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THE SPANISH ZONES IN MOROCCO

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Read at the Meeting of the Society, 16 *February* 1920.

IT is not long since the Royal Geographical Society listened to a lecture on Morocco from the lips of one of the men best acquainted with that interesting country. His report in its general character embraced a description of the whole empire. My aim to-night is different. I propose to submit to you a monograph revealing the local features and present situation of men and things in the northern and southern zones of the regions now under Spanish control. We will begin with the political definition of the territory comprised by the Spanish Protectorate.

How did the Spanish Protectorate come into being? What is its extension? I will spare you the details of Spain's historical claims on Morocco. It suffices to say that, by a logical process of reaction, or rather of revulsion, the Spanish people, almost crushed out of being by the Moors, gradually reconquered and re-peopled the territory of the Peninsula, until acquiring the momentum of energy accumulated during five hundred years it overflowed its own boundaries, and towards the close of the fifteenth century carried into its traditional enemy's country, not merely the warfare under which it had so long suffered, but also a civilization superior to that brought to its own soil by the African invader.

There is no doubt that if the Spaniards of the sixteenth and seventeenth centuries had but heeded the prophetic counsels of that genius Isabella the Catholic, one of the greatest of a nation whose women have glorified their sex as in few other lands, they would long since have turned Morocco into a magnificent prolongation of their own southern province of Andalucia. They preferred, however, the easier profit to be found, almost for the asking, in America.

But if Spain as a State and a people turned her eyes elsewhere, neither her kings nor her people were wholly neglectful of Africa, and Africa for Spain has always meant above all the Barbary States. Our monarchs maintained through the vicissitudes of an almost unceasing warfare, and in spite of almost daily aggression on the part of the Barbary pirates, more

or less continual relations with the Sultans of Morocco. Thus treaties were concluded between the two countries in 1780, 1799, 1844, 1845, 1859, 1860, 1861, 1862, 1866, 1880, 1894 and 1895, not to speak of various diplomatic missions.

Apart from official action, private individuals more and more frequently crossed the Straits from Spain and settled in Morocco, until Spanish has become the *lingua franca* on all the coast and Spanish currency circulated as freely as the native coinage. Spain's successful campaign of 1859, which culminated in the taking of Tetuan, increased her prestige in the country. In 1904 we find delimited for the first time the zones which later became the Spanish Protectorate by the Convention between Spain and France of October 3, a complement to the Treaty of April 12 of the same year concluded by Great Britain and France. The stipulations of 1904 were definitely confirmed by the Convention between Spain and France of 27 November 1912. The limits of the northern zone thus placed under Spain's protection and administration are approximately those indicated on the map (p. 334).

Right through the Middle Ages, soon after the discovery of the Canary Islands in the thirteenth century and down to the sixteenth, hardy adventurers from the Peninsula, and more particularly from the Canaries themselves, of whom the most remarkable was Don Diego Garcia de Herrera, had settled on the coast of North-west Africa, both in what is now known to us as the Empire of Morocco and even further south beyond the Wad Draa in the No Man's Land that stretches into the Sahara on the west and can fitly be described as the fringe of the Great Desert. At one time their watch-towers, keeps and castles studded the cliffs of the Atlantic Ocean in a long chain; they struck up alliances with native tribes, held others in vassalage, collected formidable armies, half Christian and half African, took part in the local wars and waxed rich by trading with the interior. Thus it is that the contour of this part of the Atlantic coast is as well known in our own day to the fishermen and small traders of the Canaries as to the natives themselves, and that many of its promontories, bays, and other natural features bear Spanish names, as is testified to at once by old and modern maps and charts. Of these outposts of Spain, reduced to-day to a heap of ruins—Tarfaya, Arxis, and the rest—the best known, perhaps the most important, was Ifni. On this inhospitable, sandy beach, to the north of the Wad Nun, there existed for a long period a Spanish fishing-station known as Santa Cruz de Mar Pequeña, originally founded in 1456. The treaty of Peace, which on 26 April 1860 put an end to the war between Spain and Morocco, obliges the Sultan by Article 8 to grant in perpetuity to Spain in that very place sufficient territory for the establishment of a fishing-station such as she formerly possessed there. This right was recognized and confirmed by Article 4 of the Spanish-French Convention of 1904 and by Article III. of the Spanish-French Treaty of 27 November 1912. The latter assigns to Spain an "enclave,"

comprised between the rivers Bou Sedra on the north, Wad Nun on the south, and on the east by a line running north to south at 25 kilometres' distance from the coast. Moreover, according to Articles 5 and 6 of the Convention of 1904 and 2 of the Convention of 1912 the Spanish Protectorate is recognized over a strip of territory between Wad Draa on the north and a line corresponding to lat. 27° 40′ N. to the south. Beyond this line Spain may at any time occupy the country adjoining her own colony of Rio de Oro on the south and bounded on the east by a straight line following the meridian 11° west of Paris.

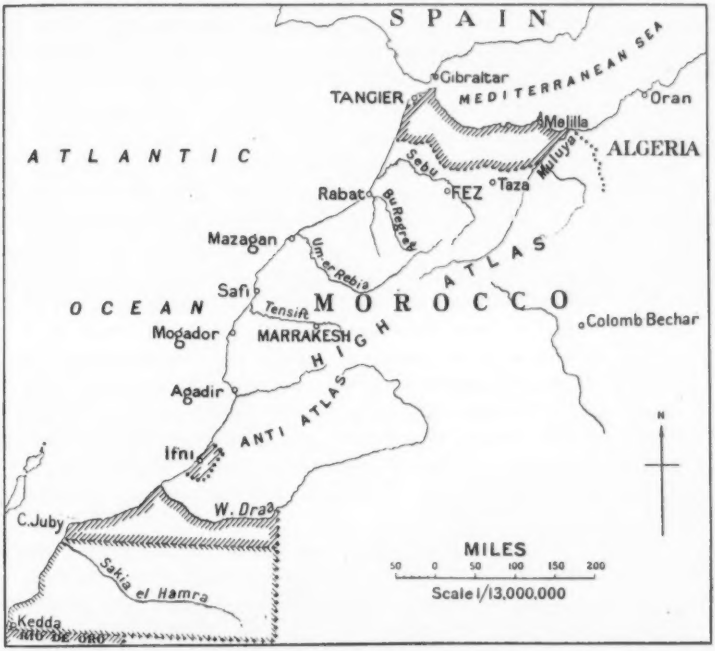


Fig. 1.—The Northern and Southern Zones of the Spanish Protectorate: boundaries hatched

It is not my purpose, nor is it possible for me, to describe with the minuteness of the material at my disposal the natural features, the ethnography and the economic situation of both zones of the Spanish Protectorate. I prefer, therefore, to devote to the northern zone the greater part of my lecture, notwithstanding the interest offered by the southern zone, of which sufficiently little is known to enshroud it with a certain charm of mystery, every day more and more dispelled by our relations with the native inhabitants.

The northern zone of the Spanish Protectorate is that part of the

Moorish Empire which stretches from the Muluya River, now in reality the western frontier of Algeria, and the sea. It is therefore in a straight line some 200 miles in length. Roughly speaking, this zone extends on an average some 60 miles inland, although it varies in depth, following the course of rivers and the crest of mountain ranges on the south. Its superficial extent is calculated to be 7700 square miles. This territory is governed by a Khalifa or Representative of the Sultan, who is at present His Shereefian Highness Muley el Mehedi, younger brother of the reigning Sovereign. His residence is at Tetuan.

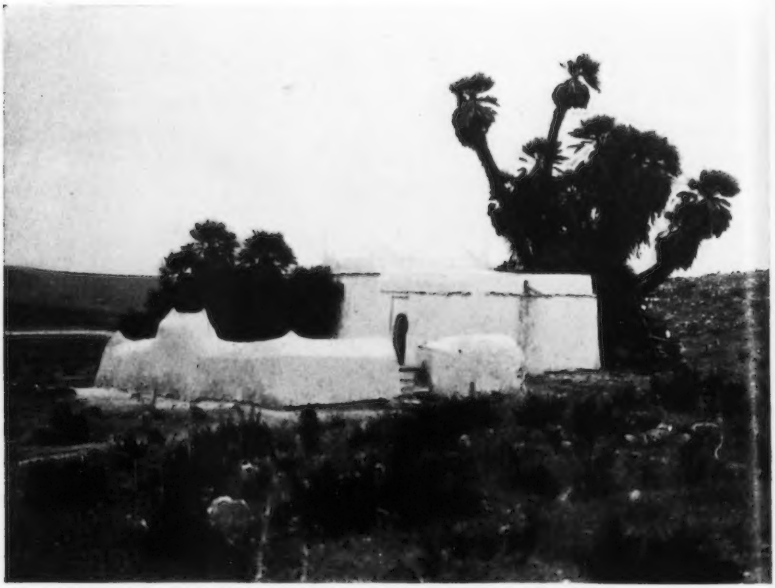
The Khalifa is assisted by a Council of Viziers, and has an organized native military force at his disposal, drilled and commanded by Spanish officers. His Highness is empowered to issue "Dahira," or Imperial Decrees as the Sultan's Delegate. His administration is under the supervision and control of a Spanish High Commissioner, who is supported by different departments for Diplomatic, Military, and Economic Affairs, Public Works, Health, etc. Spanish courts of law have been established in the principal towns, although justice is locally administered by the Kadis, or native judges, in the regions actually occupied by Spain, under the guidance of Spanish "Bureaux indigènes" and the officers of the Spanish Native Police. For natives the legislation peculiar to the country is still in force. The Spanish zone being under the jurisdiction of the Act of Algeciras, only the taxes authorized by that treaty are levied in the occupied districts. These taxes sit lightly on the population and constitute a wonderful improvement on the old Shereefian *régime*.

Although the religious law and custom had fixed the proper taxes to be paid by the natives, the greatest abuses were committed by the Sultan's Government as recently as ten years ago in all Morocco, and are the rule where the two Protecting Powers have not yet penetrated.

Until 1912 all Governorships were leased by the Sultan to the highest bidder, generally for £6000 to £8000 paid in cash plus presents and commissions to the Viziers who participated in the job. The governor or Kaid, as soon as he arrived in his unfortunate district, set to work to recoup his expenses with a handsome profit out of the inhabitants he was sent to rule and protect.

All those in authority, from the Sultan downwards, practised the most bloodthirsty methods in the just or unjust punishment of those submitted to their rule. If we add the grossest corruption and venality in the State functionaries, in the administration of justice and the registration of property, its purchase, sale, and hereditary transmission, we can easily understand that life was hardly bearable to the native and how the country was in a state of permanent rebellion, being officially recognized as Blad el Maghzen, or lands under Government control, and Blad es Siba, or the rebel country. It is thus easy to explain, moreover, why neither of the two Protecting Powers, Spain or France, has ever been

MARKET OF THE BENI BU IFRUR



SHRINE AT SIDI MOHAMMED BEN NUIS

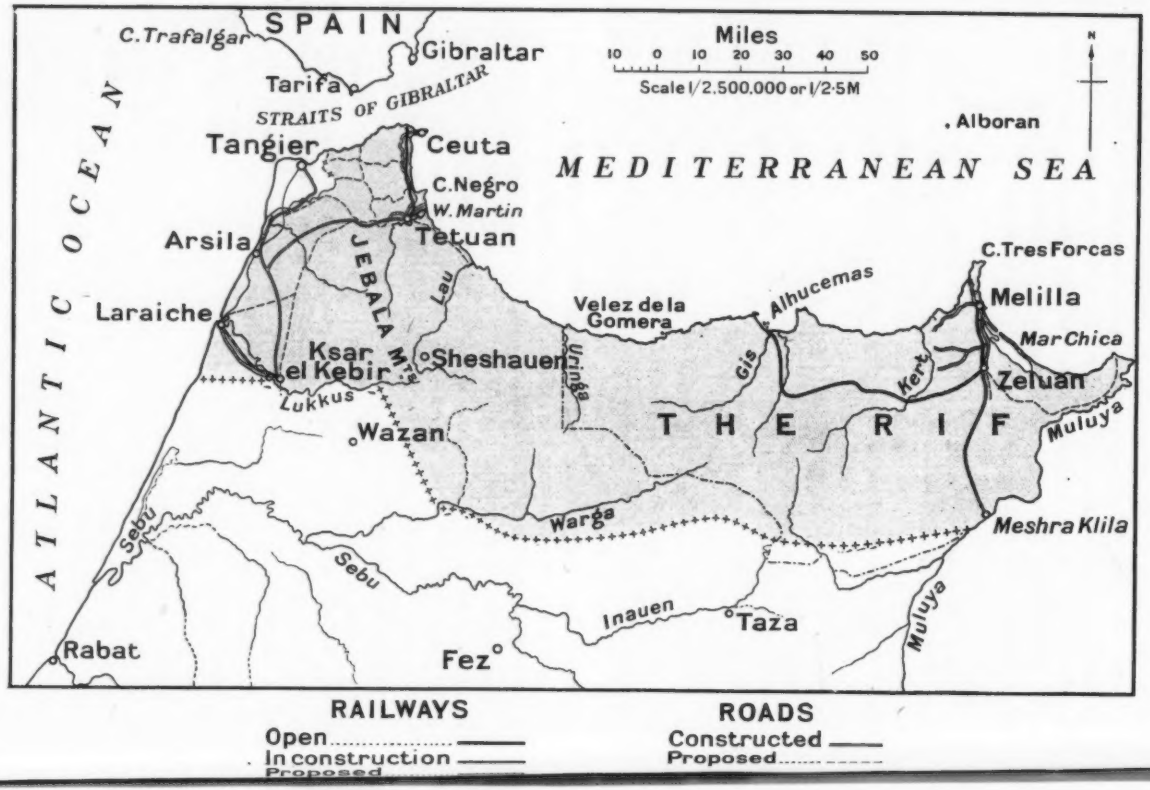
BERBER WOMEN AT A MARKET IN THE RIF

compelled to quell a rising in any part of the territory actually occupied by them. In spite of their deep-rooted prejudice against the Christian and the foreigner, the relief afforded to the native population by fair administration of justice, light and regular taxation, employment on public works, and security for agriculture, trade, and property is so great that they welcome and bear with pleasure the rule of the Rumi.

With the exception of two strips of flat or undulating country stretching from Tangier to the Luccus River on the west and from Ceuta to Tetuan on the east, both of them on the coast, the only comparatively level ground in the Northern Zone of the Spanish Protectorate is that immediately to the east of Melilla, el Garet, and the larger plain and rolling lands between the Rif Mountains and the River Muluya to the south-east and south. The rest of the Spanish Northern Zone is one mass of hills, many of which rise to more than 6000 feet. It is quite true that some of the valleys are even now smiling with fertility, and that most of the slopes and lowlands would under cultivation, a lost art in Morocco, richly repay the trouble, as they no doubt will under the sway of a country like Spain, where the farming of the dry land and the watering of the more fruitful soil have been practised for countless generations with signal success from before the time of the Roman conquest, and not with least ability by the settlers of Arab and Persian race and their Berber vassals and pupils, who, under the common name of Moors, brought mediæval civilization to such a high pitch in the Peninsula.

These facts and possibilities, however, do not alter the general character of the zone. Many people have inquired how it is that Spain has accepted such a barren and difficult territory as her share in the Protectorate. I can only recommend them to read the works published by different Spanish authors on our policy in Morocco: Gonzalez Hontoria, Count de la Mortera, Professor Mariano, Gomez Gonzalez, Jerónimo Becker, Ortega and others. The repeated and recent declarations of Spain's leading statesmen offer a more conclusive and clearer explanation than I can give to-day. You will however, I think, feel interested by the brief compendium published by a compatriot of mine in the London review, "Morocco," of 15 February 1919 and 22 February 1919, under the title of "Why Spain is in Morocco."

This clearly worded and most interesting article was specially written for the British public. It shows how Spain was not moved in her claim to occupy certain parts of Morocco by romantic dreams or mere ambitions or lust of conquest, but by practical considerations of the greatest political and strategical importance; how her parties of every shade are at one on this matter, and how Great Britain's interest is identified with ours in that occupation. We Spaniards are particularly intent on you British being well acquainted with the problem and our way of looking at it.


SPAIN
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Tarifa
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MEDITERRANEAN SEA
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Ceuta
C. Negro
W. Martin
Arsila
Tetuan
JEBALA M.s
Lau
Laraiche
Ksar el Kebir
Sheshauen
Lukkus
Wazan
Velez de la Gomera
Alhucemas
C. Tres Forcas
Melilla
Mar Chica
Zeluan
Urigha
Gis
Kert
THE RIF
Muluya
Meshra Klila
Warga
Sebu
Sebu
Inauen
Taza
Muluya
Rabat
Fez
RAILWAYS
Open
In construction
Proposed
ROADS
Constructed
Proposed

If we consider the mountain ranges of the Northern Zone we shall see that they can properly be divided into two principal blocks, although in reality belonging to the same orographic system. One of these, the nearest to Europe, runs almost due north to south, rising from the very Straits of Gibraltar, from the fortress and town of Ceuta itself, built on an outlying spur of the range, and reaching with a slight south-easterly trend to the immediate vicinity of the rivers Sebu and Warga and the fair plains of Fez. This is the Jebala chain, second only in importance and local fame to the Rif Mountains themselves. The topographical features of this region and its ethnography are sufficiently different from those of the other mountainous block, the Rif, to be separately described.

The Jebala, or Hill-land, the name of which is derived from the Arab word "Jebel," is for the most part, although not wholly, comprised in the northern Spanish zone of the Protectorate, and covers the western half of the latter. None of the heights included under the denomination Jebala exceeds 7000 feet in height; Beni Hassan is 6600, Jebel Alam 6000. The streams descending from the Jebala watershed run into the Mediterranean on the east and into the Atlantic on the west and south. The principal among them are the Wad Luccus (about 93 miles in length), the Wad Warga (about 62 miles long), of which the former runs into the Atlantic at the port of Laraiche, while the latter is an offshoot of the Sebu and the Wad Lau (about 50 miles), running into the Mediterranean to the south-east of Tetuan. Besides these, innumerable watercourses of different importance and length cover the whole of this hill region, but neither the rivers just named nor the lesser streams are navigable. Their utility is confined to natural irrigation, the Moor of to-day having abandoned that art in which his ancestors in Spain excelled.

To the east the Jebala hills join the Rif Mountains, forming a vast semicircle with them. No flat ground of any extension, only valleys, sometimes narrow and sometimes broad, break up this veritable maze. To the north-east alone a strip, some 25 miles in length and some 5 or 6 in depth, runs from Ceuta to Tetuan between the foothills and the sea. It belongs to the Hauz, or coast-land of Tetuan. This town itself, at the mouth of the not very imposing Wad Martil, is built in one of the broadest valleys to be found in this part of the country, running from the south-east to the north-east just beyond the Mediterranean mouth of the Straits of Gibraltar.

On the west, the Jebala hills are separated from the Atlantic Ocean by the smiling valleys and broad plains of El Gharbia, Es Sahel, Khlot and Tilig. These are watered by the Marharhar, the Hasheff, the Garifa, the Luccus, and a host of minor streams, some of which, but only the smaller number, dry up in summer. The total area of these lowlands is supposed to cover some 900 square miles, as far south as the border-line.

The natural characteristics and agricultural value of the country differ very considerably. The highlands are fairly well covered with

century-old cedars, wild cork and olive trees, ilex, pines, arbutus, pistachio and carob trees, box, lentisks and laurustinus along the brooks and rivers. In the valleys grow neglected but luxuriant fruit-trees; orange, apple, cherry, mulberry and pomegranate, walnut and chestnut trees; their slopes are sown with wheat, barley, maize, and millet, and a few vines where Christian settlers, untrammelled by the precepts of the Koran, dare to cultivate this plant and to rear pigs. The flora and fauna of Northern Morocco are not yet African. They are those of the Mediterranean shore, and differ but little from what is to be seen across the Straits in the neighbouring Andalucia. Few countries deserve better than this part of Morocco the beautiful name of "Land of Flowers."

The domestic animals to be found in the poverty-stricken villages, or Dchra (from Dchar), of the Jebala uplands are a limited number of cattle, small in size, peaceful of disposition, and generally dun in colour; ponies and donkeys for transport along the hill paths; sheep and goats fed on the rich green grass of the glens and lower spurs of the hills in flocks more numerous than the herds; and unending troops of poultry, whose diminutive size gives the wished-for sarcastic touch to the cynical Moorish proberb: "The country is never quieter than when there is one fowl for five men." Around the huts and all over the hill-sides swarms of buzzing bees feast on the strongly scented flowers and herbs.

No picture of a Moorish village or farm-yard is complete without the addition of a pack of savage mongrels, whose striped coat, pointed muzzle and snarling savagery suggest a wolfish descent or more probably an alliance with the jackal, the existence of wolves in Morocco being, to say the least, doubtful.

Such are the Jebala highlands; a rugged region of wild beauty, neither rich nor poor in its soil and natural products, wind-swept and drenched by showers of semi-tropical rain for six months of the year, and during the other six dried up by a sun as scorching as the Levanter from the desert which fans the crags and rushes down the valleys into the plains and towns of the west. Of the people bred in these austere surroundings we will speak presently.

But first would I say a word of the lowlands; of the Gharbia, Es Sahel, Khlot and Tilig, the last named of which extends to just beyond the northern Spanish zone into the smiling land of Sefian. The Gharbia is divided from the poorer region of Tangier, where rocks and marshes alternate with a heavy clay, by the Akba al Hamra hills, once famous for their brigands and the treacherous quicksands of the Tahadarts river flowing a little further west into the Atlantic. It is a succession of rolling hills green with grass or sprouting crops in the early spring, with a river or stream in every little vale; smiling land indeed, though without a tree. To the west and south the Gharbia, or little Gharb, merges gradually into the Sahel or sandy coast-land. Great patches of esparto grass and palmetto begin to appear, and remains of once great forests are

still to be traced in the Gaba or woods of Es Sahel, Bujaren, and Laraiche. The picturesque little coast town of Arsila (30 miles to the south-west of Tangier), with its old Portuguese battlements and towers on a low rocky pedestal resting in its turn on the beach of firm white sand which sweeps like a vast crescent from far-away Cape Spartel, was built at the boundary-line of El Gharbia and Es Sahel as Laraiche at that of Es Sahel and Khlot. To the north its walls are kissed by the insignificant Wad el Kelu, while to the south and east they are surrounded by a deep moat wondrously overgrown and filled in by a wealth of cactus, prickly pear, laurustinus and fig-trees, entwined with flowering creepers, among which is ensconced the sanctuary of a local "Marabut," rearing its dome of glistening white but a few yards from the ever-breaking surf of the Atlantic. Arsila, the only port besides Laraiche in all the western part of Jebala, of which it is the capital, has no monuments worthy of mention, but is to be remembered as the residence of the notorious Raisuli during his governorship of the province.

For the lazy Moorish peasant with his primitive, unsatisfactory implements the Sahel is a barren land, but qualified Spanish explorers (see Cereceda, 'Yebala y el Bajo Luccus,' pp. 207 and 208) not only regard the light red sandy soil as most favourable for afforestation, but as capable of bringing forth abundant crops. To that same indolent cultivator the districts of Khlot and Tilig bordering on the Sahel to the south must, on the other hand, seem an ideal ploughland as to the traveller they appear a Paradise. Here it is that the famous red earth, or *hamri*, a mixture of clay and silicious sand and chalk, and the rich black argillaceous loam, or *tirs*, 5 or 6 feet in depth, first appear. This is the wonderful soil which, thanks to a happy combination of nitrogen and potash with clay and loam, through thousands of years produced with hardly any preparation and no manuring such crops of wheat, barley, and millet as are not known elsewhere from Morocco to Bessarabia. It is from this same fat earth and from better sorts of hamri that the provinces of El Gharb, Abda and Dukkala in the French zone draw their incomparable agricultural wealth, which in the opinion of many outvies the mineral riches of Morocco. Over the broad flat expanse of Khlot and Tilig roam countless horses and mules, herds of cattle and flocks of sheep, akin but far superior in quality to those of the Jebala. Their numbers and appearance revive the memory of those described in Scripture; indeed, the scenery, people and customs of all this region savour strongly of biblical times, just as the Jebala are Virgilian in their rusticity.

El Ksar itself (about 10 miles from the sea and 22 from Laraiche) has nought to recommend it to your attention save the fact that it is the capital of the prosperous Khlot region. The great battle fought in its vicinity four hundred years ago is but a memory, although it cost the life of three kings, among them the romantic Don Sebastian of Portugal, with

the flower of his chivalry; of its once famous walls there is hardly a trace, and its habitants are not ten thousand. This is the number of those that people Laraiche, the port at the mouth of the Luccus, which not only is the sea-gate of this south-western portion of the Spanish zone, but was for long the starting-point and terminus of the traffic to and from Fez. Laraiche, occupied by Portugal in 1504, and ceded to Spain in 1610, remained in our possession for seventy-nine years, until in 1689 it was recovered by Muley Ismael, Morocco's greatest Sultan. The old ramparts and towers are largely Spanish. Although the entrance to the port is made difficult by the dangerous bar, as so often happens in Morocco, Laraiche promises to gain in importance when the new harbour works are completed. Like most of the towns in this northern part of the empire, it has little or nothing of interest to show the traveller, but much that is picturesque. As you toss in a Moorish barge amid much shouting and the chant of the native boatmen over the triple line of surf, nothing reminds you more of a pirate's stronghold than this old town, strung along the high southern bank of the Luccus in a succession of terraces. In the vicinity the ruins of the Phœnician and Roman Lixus may prove attractive to the archæologist, although less so than Volubilis and Meknés in the French zone. Close to Laraiche one rides through the beautiful Gaba, or grove of ilex and cork trees, the remnant of a great forest, and passes on the way to El Ksar through the Adir or great Crown Estate, which until recent years had been neglected by the Sultan and his Government, so that the stud and herds of picked horses and cattle now run wild over its pastures and among its woods and marshes.

If from the extreme west we turn to the north and east of the Jebala hills we shall discover on the map the other flat strip of country referred to at the beginning of my lecture, running from Ceuta to Tetuan (23 miles). Having ridden from one town to the other, and forded the different rivers which under the names of Wad Smir, Rio Negro, and Fenidek stream down from the heights only 3 or 4 miles off the beach, I can testify to their insignificance and to the unpromising aspect of this sandy soil, half swamped in parts by pools of brackish water and more plentiful in reeds and brushwood than in crops. Yet the Spanish experts who have examined this belt, the border-land of Andjera, towards the Mediterranean, while recognizing its deficiencies, are hopeful of its future under proper drainage and cultivation. It is cut in half by an outlying spur of the Andjera chain projecting into the sea under the name of Cabo Negrón, or Ras el Tarf, the scene of different engagements between the Spanish troops and local tribes. At its foot we find El Medik, of which more anon.

Eighteen miles to the south-east lies the town of Tetuan, on the last easternmost slopes of the Jebel Dersa overlooking the open valley of the Wad Martil and opposite the frowning snow-covered peaks of Beni-Hozmar, Jebel Bu Zeitun and Beni Hassan. Few towns in the world

can equal this situation; few even in Morocco can rival its Oriental charm; and certainly in my opinion, the artistic beauty of its houses and gardens, none nearer than Fez. It was from these gardens and orchards, famous in all Morocco and in Spain, that the oranges known as "tangerines" originally came, a source of wonder to all who have in recent times visited those neglected enclosures, where the trees unpruned and untended were dying in the deadly embrace of creepers run wild, or eaten up by moss and parasitical insects. Horticulture is not practised by the Moor, and I have always shrewdly suspected that the gardeners who planted out and kept his not very numerous olive groves and fruit-trees in the past were Christians once working in thousands as slaves of their Barbary captors, but with whose disappearance the finer branches of cultivation, bridge-building, and public works generally seem to have died out until the advent of the era of Protection.

The population of Tetuan is to-day about 30,000 civilian inhabitants, of whom five or six thousand are Jews and three or four thousand Europeans, nearly all Spaniards. Its port, though exposed to the east, which on the northern Moroccan coast signifies a great disadvantage on acccount of the prevalence and force of the Levanter, was always active, and now more so than ever since our occupation. Tetuan has her railway now, linking her up with her own port and Rio Martin, and another connecting her with Ceuta and Europe; a few months hence she will see another building on the road to Tangier, and is already surrounded by modern highways and bridges, of which one already reaches far out towards that town. The importance of Tetuan has been enhanced of late years by the establishment there of the residence of His Shereefian Majesty's Khalifa, H.E. the Spanish High Commissioner, and their respective Departments. The base and headquarters of considerable military forces, it is, moreover, now surrounded by cantonments, hospitals, and a new European quarter erected outside the walls in order to efface as little as possible the picturesque aspect of this lovely Moorish town.

Another and up to now inviolate city will soon be revealed to European eyes at a point about 30 miles to the south-east of Tetuan. Built towards the close of the fifteenth century by certain fanatics desirous of avoiding all contact with the advancing tide of Christian civilization, Sheshauen was from its birth a holy place. The site selected was the territory of the Khmas tribe, the very heart of Jebala, isolated between the savage Rif country to the east and the rampart of the principal Jebala range on the west, thus effectively ensuring during more than four centuries absolute seclusion and peace for the Shorfa who govern this townlet of some 5000 inhabitants. No European has ever trodden its streets, although in 1883 the courageous French explorer, Vicomte de Foucauld, disguised as a native, was able to reach its suburbs, and lucky enough to get back therefrom with a whole skin, after being turned back by the authorities. Sheshauen's veil of mystery has, however, already

been lifted by indiscreet Spanish aviators. A few months ago photographs were taken from the air, and it is probable that next spring Spanish troops will be within its walls. With this ends my rapid description of the natural features and towns, five in all, of the western portion of the northern Spanish zone of the Protectorate.

Of the domestic fauna I will say little. The native horses, mules, cattle, sheep, goats, and poultry, if decidedly requiring improvement, are susceptible of developing into fine breeds of their kind. In like manner European methods applied to the existing cereals are preferable, given the climate and soil, to experiments in foreign varieties. On the other hand, the development and increase of vineyards, olive groves and esparto fields, the introduction of fruit-trees of various kinds and the cultivation of vegetables, careful afforestation in some districts, and the regeneration of the existing species, especially of the cork and carob trees, as also the scientific cutting and replacing of native woods, is imperative if the country is to give a full yield of its resources. The cotton-plant, above all, seems to offer bright prospects to those who should care to rear it in the certainty of obtaining qualities similar to those attained in Egypt and the United States. Morocco unites the climatic conditions of the first with the "black cotton soil" of the latter. The tobacco plant grows wild in many places.

Wild animals are limited to the jackal, fox, hyena, baboon, and boar. Lions, fairly numerous a century ago, have been wiped out by the repeating rifle. Wolves do not appear to exist, and Europeans have not seen the wild cat and lynx of which there is rumour.

Sweet-water fish are not as common in this part of Morocco as farther south, although some shad may be caught in the larger rivers. The wonderful wealth of sea fish makes up for this deficiency, the Mediterranean and Atlantic coasts being among the best in the world for variety and quantity. Spanish steam-trawlers have been working there for many years, and curing and salting establishments at Ceuta and Melilla, particularly for sardines.

The climate of Northern Morocco is partly Atlantic and partly Mediterranean, although mainly under the latter influence. The temperature in the lower regions varies much, from 2° C. to 38° C., sometimes fluctuating about 18° in the twenty-four hours, the nights being generally much colder than the days. On the higher levels no proper statistics seem to have been compiled. Heavy rains, usually in the form of showers, fall continually from November to the end of April, and are preceded and followed by lighter falls in October and May. Rain in the intervening period is practically unknown. In the plains on the Atlantic coast 400 to 800 millimetres rainfall have been registered. Blustering west and south-west winds from the Atlantic are common, and in summer the dreaded Levanter's scorching breath seems to kill life within the body. Even horses and mules are affected by it.

NATIVE FARRIER AT EL JEMAA EL TELAT

RIF WOMEN SELLING EARTHENWARE AT THE MARKET OF EL ARBAA DE ARKEMAN, SOUTH-EAST END OF MAR CHICA

BERBER HOUSE OF THE BETTER CLASS, BENI BUGAFAR, EASTERN RIF

TYPICAL BERBER HOUSE AT FRAJANA, 5 KM. WEST OF MELILLA

For a fuller knowledge of the fauna, flora, climate, and geology of the northern Spanish zone I would recommend the perusal of the Reports of the Spanish Society of Natural History, of the little volume 'Djebala' by a mission of explorers sent out in 1913 by the same Society, the Yearly Reports of the Public Works Department of the High Commissioner at Tetuan, the *Proceedings* of the Royal Zoological Society of London, particularly papers by Messrs. De Winton and Waterhouse, Debrel's works, 'Modern Morocco,' and numerous French publications.

Minerals do not seem to abound in the Jebala as they do in the Rif, although it is true that the south and eastern portions have not yet been prospected. Near Ceuta a very remarkable vein of antimony, already tapped, is found; some traces of coal on the slopes of Jebel Dersa; and elsewhere pockets of iron and possibly other deposits. Some signs of petroleum have been noticed in the marshes of the Khlot and lower Jeba district. No accurate information as to the mineral wealth of this or most parts of Morocco can be given until the country is more extensively and closely prospected than its state allows of at present. I would, however, recommend the perusal of the Report published by a Special Government Commission in the Bulletin of the Geographical Institute of Spain for 1917 (Boletin del Instituto Geologico de España, 1917).

Let us now turn our eyes towards the Rif. This ancient land, once the Gomere province of Mauritania Tingitana, forms the eastern half of the Northern Zone of the Spanish Protectorate. It differs but little from the Jebala in its fauna and flora, so far as is known, but it has always been more or less closed to Europeans since the Arab invasion in the eighth century. More than two-thirds of its total area is occupied by an intricate system of mountains and valleys, the former apparently of lesser height for the most part than those of the Jebala, but in many districts much more denuded of vegetation. This region comes under the Mediterranean climatic *régime*, and towards its eastern portion begins to resemble Algeria, from which it was separated by the former Shereefian province of Angad, the Trifa plain and the Beni Iznaten and Beni Snassen, all of them beyond the Muluya River, and therefore in the French Zone. It is here that we find the plain of El Garet Bu Areg and higher tablelands of Mtalsa and Guerruao, all close to the lower Muluya River, where is the Zebra plain, one of the most important of the Rif. The Muluya, although ending its course in sandbanks and marshes, meets the mountainous country again towards its mouth in the low hills of Kebdana. With the exception of the shores of Temsaman on the Mediterranean, this is the only flat land on the Rif; its total area is some 800 square miles.

There has been some discussion among writers as to the political and geographical limits of the Rif. The most reliable description appears to be that which assigns the Muluya, the old Roman frontier, and the Wad

Uringa as its terminal landmarks from east to west; the Mediterranean on the north; and the Benibu Yahi and Beni Hassan Mountains on the south up to the sources of the Warga River, whence a line with a slight northerly trend should be drawn until it meets the Uringa.

The Rif Mountains rise chain behind chain in crescent formation almost parallel to the Mediterranean, merging in the west into the Jebala range, of which they appear to form a geographical whole. Their principal peaks are Ain Zorah, Jebel Arzú, Jebel Mezgut de Guiliz, all on the south and south-east. None of these can claim more than 7000 feet in height; the other ranges, always allowing for discoveries, are still lower, but are generally steep and rocky, and often covered by dense forests.

The principal river is the Muluya, the fifth in importance among all the known watercourses of Morocco, coming after the Sebú, Um-er-Rbia, Bu-Regreg and Tensift; the Warga is the next, and lastly the Kert. Not one of these is or will be navigable. The lesser streams of the Rif, although numerous enough and most useful for the irrigation of the country, are wholly insignificant except as landmarks.

Much wilder than the Jebala, the great difference between the eastern and the western portions of the northern Spanish zone consists from the purely material standpoint in the great known mineral wealth of the Rif. I speak advisedly of the known mineral products because, as I have observed before, the future may be keeping some revelations in store with regard to the Jebala hills.

The mineral riches of Morocco have unfortunately been much exaggerated, to the great disappointment of many and the country's own harm. This cannot be sufficiently repeated. In the Rif, however, there are, no doubt, important deposits of iron ore (hæmatite, etc.), antimony, copper, lead, zinc, and silver, particularly in the south-eastern district. As the latter has been occupied by Spain in some places for the last ten years, and others more recently, much of the land has been properly prospected, and some really valuable iron and lead mines are being successfully worked at Mounts Uixan and Afra (Beni-bu-Ifru), while others have been opened at Cape Tres Forcas, and there is a great promise of fine results in the Beni-Urriaguel hills. Let not any of my hearers imagine, however, that I am offering them a tip or a clue. The whole territory of the Moorish Empire is covered by overlapping mining claims to such an extent that an international court has been established for the sole purpose of deciding them.

There is not one single native town in the whole of the Rif. The inhabitants cluster in villages, of which the largest contains two or three thousand at the most, although this is quite exceptional. The nomads of the plains and plateaux of the east live in tents. As a result, the only towns are the old Spanish coast establishments of Melilla, Alhucemas, and Peñon de Velez. In the first of these some natives have always resided,

none in the latter, as they have to keep on the defensive against sudden attack or treachery.

Agriculture is at the lowest possible level nearly all over the Rif, partly no doubt on account of the dearth of outlets for the local produce, due to the natives' own voluntary seclusion, but also to their unwillingness to work on the "sic vos non vobis" principle. The Rifi is nothing if not an individualist. He is well aware that the fruit of his work will either go to the "Maghzen" in the very rare case of his paying taxes, or to the petty local authority, the village sheikh, or again to some religious worthy, the "Shorfa," "Marebet" or "Zauia." He therefore grows enough for his own sustenance and that of his family, and troubles no more.

Statisticians in all countries are to be pitied, and this is particularly true with regard to the statistics of the population of Morocco. Registers of births and deaths are not kept in that happy-go-lucky land; the census is even now confined to the towns under European rule. Without doubt the natives would, as in some of our "civilized" countries, avoid it as a bringer of misfortune, for on this account nothing is more indiscreet, nor for the matter of that useless, than to inquire after a Moor's age or celebrate his birthday, both of which are in general unknown to him.

As far as can be affirmed with any degree of certainty, the native inhabitants of the Northern Zone of the Spanish Protectorate number little over a million. Of these it is supposed that the Rif contains some 560,000. They are divided both in the Jebala and the Rif into numerous tribes, the names of which are pretty well known, but as the patriarchal system is really the foundation of their political and social life, these principal groups are subdivided into an infinite number of fractions, or "rboa," which in their turn are liable to multiply at any time, either through an increase in the population or the breaking away from the parent stock, the result of necessity to seek their sustenance in new ground, or of the unending internecine quarrels, which are a plague over the whole of this otherwise pleasant country.

The fundamental strain of the peoples in this part of Morocco, with some few exceptions, is the Berber race. The Jebala and the Rifi, although similar in some respects, differ from each other sufficiently to make a separate description inevitable. The greatest distinction between them, greater than any natural features and therefore the only adequate reason for not treating them as a whole, is a double one. In the first place, the Jebala mountaineer has adopted the Arabic language, although not wholly. Moorish Arabic, particularly the spoken tongue, is rarely of the first quality. The Jebli, besides keeping his peculiar accent, interspersed his speech with Berber words or forms. The tribes confining on the borders of the Rif, such as Ktama, Beni Seddat, Metzuia el Jebel, some fractions of Gomara, etc., have no Arabic; they have remained

faithful to the aboriginal "kbail" different from the "Tamazirt" of the Centre and the "shelloh" of Southern Morocco.

Secondly, he has become slightly mixed among the outlying tribes, at all events, with Arab blood, has swallowed a certain amount of civilization and softened his manners to some small extent. Whether by intercourse with the Fasi refinement as in the case of the Bani or southern hill tribes, or by contact with the Europeans at El Ksar, Laraiche, Tangier, and Tetuan, for many of his people are in service or trades in these several towns, he has come to recognize or tolerate certain forms of government and even some duties. He has been known to come down from his hills and pay tribute to his nominal governor at Arzila or Tetuan, particularly after a successful foray by the Sultan's "mehallas." On the whole, however, he is very much himself and still acknowledges his rifle as his only lord spiritual or temporal. In other words, the Jebala, in great part Blad-el Maghzen officially, is in reality Blad-es-Siba, or permanently rebel country, and when not actually under the range of firearms does what it chooses.

These tribes are twenty-one in number (El Haus Tettauen, Beni Madan, Beni Said, Beni Mesauar, Jebel Habib, Mernisa, Beni Gorfet, Ahl Serif el Jebel and Utáa, Beni Zerual, Serrak, Gomara, Ktama, Beni Ider, Wad Ras, Beni Hosmar, Beni Hassan, El Khmás, Beni Arós, Zumata, Beni Issef, Gzaua, Beni Bu Selama, Beni Laitz, Mtuia el Jebel). If we reckon the Andjera tribe the list is complete as far as the Spanish zone is concerned, but this latter has never remained permanently within the very loose confederation formed by the rest. The Andjerines, once feared as pirates or coast robbers in the vicinity of the Straits of Gibraltar, and still wreckers and pillagers of stranded vessels, are the inhabitants of the north-eastern corner of the North African promontory, at whose extremity lies the Spanish town and fortress of Ceuta.

In general appearance there is little to distinguish them from their congeners, in spite of a probably stronger strain of Arab blood. The Jebala are generally men of magnificent physique, often over 6 feet in height, always broad chested and stout limbed, with lungs of leather and sinews of iron. They are frugal to the extreme, particularly among the poorer sort, contenting themselves with a piece of barley-bread, a few onions or figs and milk, fresh or sour (lebén), butter, tea, and sugar as their food all the year round. Splendid marksmen up to 300 yards, after which, in spite of their boasting, their aim is doubtful, as they despise the use of the sight, which they seem unable to understand, unwearying on the march, provisioning themselves for days with the scanty victuals they carry in the hood of their "jellaba," brave and quick to grasp a situation or the possibilities of a position, they make magnificent infantry soldiers, second only to their brothers the Rifi. Their arms are a repeating rifle, for the possession of which a man will give his whole fortune, risk his life, or stab his own father, and the curved "kumia" common in all Morocco, with

which they make terrible wounds and perpetrate ghastly mutilations. With his magnificent presence, the frank, open look in his brown or blue eyes—for many of these men are as fair and white as any Saxon—his swinging gait revealing the free man who has never known a tyrant, the Jebli would be most attractive were one ignorant of his treachery, his cruelty, thievishness, and immorality, the sad inheritance of far-off Phœnician traditions. His redeeming trait, shared in common with most Mohammedans, is his affection and reverence for his mother and his hospitality within his own house and village.

To his womankind the Jeblí is hard beyond expression. A daughter is a chattel to sell to the highest bidder all over Morocco, and a wife at once a slave and a draught animal. In fact, many small farmers marry the three wives allowed by the Korán only to have the means of ploughing more land, for were some of the young ladies enlisted in the land army to volunteer in the same capacity for Morocco they would be expected to allow themselves to be yoked with the donkey or the cow, a spectacle no longer surprising for old residents in that country.

The Jeblí is vaguely Mohammedan in his religion, the principal tenets of which he hardly knows and certainly observes with some carelessness, particularly in the essential matter of daily prayer. In many tribes not even one mosque can be found, and the only duty to which the Jebala people remain faithful with admirable steadfastness is that of the Ramadan or yearly strenuous fast. As education in the native schools deteriorates most deplorably year by year, doctrine becomes perverted, mutilated, garbled by ignorant masters and only imperfectly learnt by the young. As a consequence superstition of every sort is rife, the purer observance of the Prophet's teaching is replaced in practice by the veneration of a host of greater or minor "marabet," whose sanctuaries literally cover the land, and by adherence to various sects of which several are in fact heretical, or at least given to abusive practices. Such are the Jebala, of whom the authors best qualified to judge calculate that some 495,000 inhabit the northern Spanish zone of the Protectorate, and of them some 100,000 warriors.

To speak of industry and commerce under these conditions is, you will easily understand, absurd. The mountaineer is clad in cotton undergarments and a cloth waistcoat, made of material spun at Manchester and Roubaix respectively. Over this light dress he wears a "jellaba," or cloak, not unlike a "poncho" with sleeves. The stuff used for this outer apparel is a rough brown cloth of frieze-like texture, spun, dyed, cut and sewn by the women of his village. With the exception of the brown jellaba cloth and a certain quantity of coarse white woollen stuff, no other article save the immense native straw hat and a little pottery is manufactured by the hill villagers. Beyond this work they have no industry. Their trade consists in the sale of charcoal and poultry, but they are great buyers of tea, sugar, cotton cloth, rifles and ammunition.

The Rifi, as we know him, appears to be the prototype of which the Jebala has become a tamer species. Practically free, in the mountain region certainly, from any admixture of Arab blood, his language in every hill tribe is the Berber Kbail, the tongue of his race, which, save perhaps for some Phœnician, Carthaginian, and Roman strain on the coast, has come down intact to us. Twelve times, say the Moorish Chronicles, was Islam imposed on the Rif by the scimitar of the Arab invader, and twelve times was the yoke thrown off, although at each successive rising the land was drenched with blood. At last the Rifi conformed outwardly to the new religion, but in his heart he has never entirely accepted it, if we are to judge by his lax practice of the Koranic precepts and sometimes pagan and sometimes Christian rites in which he still secretly indulges. He has allowed his country to be accounted a province of the Shereefian Empire; he has consented to the building by the Sultan's Maghzen of a few isolated and now ruined fortresses, provided always that they served to support his resistance to Christian incursions, as at Zeluan against Melilla and at Ajdir against Alhucemas; he has even countenanced the appointment of Adel, or notaries, among his own people as functionaries useful for the more or less legal transmission of landed property, but he has taken good care to keep the Rif Blad es Siba or rebel in its entirety.

Far more energetic, hardier even and braver still than his Jebala brother, he is a yet more redoubtable and handier fighting man; his skill at taking advantage of the lie of the land he knows so well and of every crag and crevice is far greater, and his ferocity so cruel that no foreigner is allowed to live where the Rifi rules. Even the humble, necessary Jew is hardly able to exist among the tribes except as the serf of some powerful warrior whose protection he thus dearly buys for the purpose of working as agent of a wealthier principal in the counting-houses of Tetuan, Tangier, and Melilla, for were he to accumulate riches in the land itself they would soon be taken from him, probably by his protector himself, and his head would go with them. Rif treachery is proverbial throughout Morocco, and the tales told of *difat* or banquets to which life-long foes are invited, with honeyed words of reconciliation the better to stab them unawares, and others of the same sort, are as blood-curdling as the choicest from Afghanistan, so like the Rif in more ways than one. As in Jebala, there are no permanent rulers among the Rifi Kbailia; the Jemaa, or popular assembly, is supreme and delegates its authority, often in an irregular and corrupt form, to the "shioj," whose election generally leaves a few score voters stretched out on the hill side. Life is worth even less than in western Morocco, and relations between man and man, even those of the same family and living under one roof, are yet more precarious.

Still less than the Jeblí has the Rifi founded any large centre of population. Whereas the former, in humble imitation of the architecture to be seen in the coast towns, builds himself, when he has the means, a low, square cottage of stone and mortar thatched with twigs or rushes or

roofed with tiles, the Rifi, obstinate in tradition as old as his race, lives in a flat-roofed house of small stones loosely placed without mortar one upon the other with no binding matter to keep them together, following in most cases the outline of an oblong plan of which the type reminds the spectator of ancient Asiatic dwellings. The Berber Rifi's industry and trade can be placed on the same level as those of the Jebala peasant.

Of these the best fighters in Morocco there are some 75,000 armed with rifles of modern patterns from all the principal European countries, whose gun-running merchants have no cause for jealousy between them. The Hill Rifi form some twenty-five tribes with 320,000 souls out of a total population of some 540,000. The names of these clans are: Beni Ahmed, Beni Amreth, Beni Bexir, Beni Bu-Yahi, Beni Bu-Nser, Beni Bu-Shibet, Beni Bu-Frah, Beni Gmil, Beni Itteft, Beni Jennus, Beni Mezduy, Beni Said, Beni Sedat, Beni Tuzin, Beni Uariagal, Beni-Ulixec, Boccoia, Guelaia, Kebdana, Kzennaia, Mgaua, Mtiua-el-Bahar, Tafersit, Terguist, Temsaman, Zerket.

The only towns in the Rif are Peñon de Velez de la Gomera, Alhucemas, and Melilla. All the three are Spanish. Velez, once an outpost of the Visigoths of Spain, was occupied by order of Ferdinand the Catholic in 1508. It is only some 90 yards from the coast, and its half a thousand inhabitants are accustomed to continual brushes with their turbulent neighbours, having on occasions to cover over their streets with sand-bags, as they can easily be fired into from the cliffs of the mainland. Further east el Peñon de Alhucemas, at about a mile from the coast, on one of a cluster of three small islands occupied by Spain in 1673, houses some four hundred people. Both these positions are fortified and garrisoned against attempts from the coast. The Rifi are always on the watch to prowl round these islets in their "cárabos," or light high-prowed rowing boats: equally ready to fish, sell their catch in Melilla, or attack and loot a becalmed sailing-vessel. These descendants of the old Rif pirates oblige the masters of all craft sailing through this part of the Mediterranean to give their dreaded coast a wide berth. Melilla, the third of the old Spanish strongholds, was originally built on the site of the Phœnician and Roman trading-station of Rusadir, at the base of the great promontory of Tres Forcas. Conquered from the Moors in 1497 by Pedro Estupiñan, one of the Duke of Medina Sidonia's captains who had distinguished himself at the siege of Granada, and the scene of a long series of homeric fights all through the seventeenth and eighteenth centuries, Melilla became a flourishing town and the principal centre of trade in the Rif. Under the advantages afforded by its position as a free port, where no customs dues are levied, Melilla has for many years offered to British imports a gateway into this region of Morocco.

Melilla was again attacked by the neighbouring tribes in 1893, and it was from there that in 1909 the brilliant operations were conducted which

ended by giving Spain her present position in the Rif. The town has prospered greatly, its population increasing from 13,000 in 1907 to 77,000 at the present time, but of this I will presently give you further details.

If we now turn our eyes to the relatively flat fringes of land situated respectively to the west of the Jebala and to the east of the Rif Mountains, we shall see that they can properly be considered as the Marches of the two hill districts in question. It is here that the Arab race and mode of thought and its visible representation, the Shereefian Maghzen, have made most headway in all the Northern Zone of Morocco, although not always in the same way or to the same extent.

On the west the tribes, although of Berber origin, show all the characteristics of the dominant Arab strain. Following a pastoral and agricultural life, they build their so-called farms and their villages on the smiling slopes of the Gharbia, or on the plains of the Sahel, Khlot, and Tilig countries, from which they have taken or to which they have given their names. A few live in tents, others in the market town of El Ksar el Kebir. Their horsemanship is as good as any among the natives of Morocco, and their breed of horses one of the best. While partial to razzias and local fighting, they are on the whole much more peaceable than their neighbours, the Jebala, and much more amenable to authority, showing respect to the Sultan's Government and submission to the Kaids who represent him, and often by long and even hereditary tenure of their office end by occupying a position akin to that of a feudal lord.

The inhabitants of the plains and tablelands comprised between the Kert and the Muluya in the south-eastern corner of the Rif are either half Berbers and half Arabs, such as the M'talsa, the Beni-Bu-Yahi and the Ulad Bekhar, or totally Arab, like the Ulad Settut. The two former number respectively 44,000 souls with 6000 rifles and several hundred horsemen, and 68,000 souls with 10,500 rifles and 400 horsemen; the two latter, 8000 souls and 1200 rifles and a few horsemen, and 4000 souls with 600 rifles and less than a hundred mounted men. The Beni-Bu-Yahi and Ulad Bekhar are Arabs by race and in tongue. They are nomads, and like the former breed inferior horses, cattle and camels in great numbers.

No greater contrast is possible in the same people than between these wild men with their abject, down-trodden womankind and the courteous, affable, polished Moors of the coast towns. Among them I have many good friends. Observers of the Malekite rite, and recognizing their own Sultan as Great Shereef or visible Head of their religion, they affect to discard bright colours and precious metals. Their austere interpretation of the Koran prevents all unbelievers from entering their Mosques, and renders them impervious to European teaching, and in many respects to material and artistic progress, so that their mental attitude is fixed in that immobility peculiar to the East, from which they draw, with their

mode of thought, their manners and customs. In race they represent a fusion of Berber and Arab blood. It is easy to discern among them the Moor of Spanish origin, the Andalus, always an exile though often expelled from Spain by political enemies before the Christian conquest. These men form a kind of aristocracy in Morocco, and are generally in Government employ. The Moor of the better class, when not a trader or a State official, a judge, a notary, or a lawyer, lives on the rent from his houses in the town or the farms in the outlying country districts. Beyond a few looms and water-mills in Fez, a degenerate carpet factory at Rabat, some last remaining leather-workers, the making of 'azulejos,' or coloured tiles, and other crafts connected with a degenerate form of house-building, no industry can be said to exist in Morocco of to-day. Her exports are almost wholly confined to agricultural produce.

The Jews of Morocco are supposed to number 200,000. Less than one half reside in the northern Spanish zone. They are in great part of native origin, some among them immigrants at a very remote period, but many of them belong to the aristocratic Sephardim, or Spanish Jews, bearing Castilian names and speaking the Spanish tongue in preference to any other. Educated on European lines, these Spanish Jews represent in Morocco an active element of civilisation and progress, particularly in the towns, where, as in the Spanish Zone, they are no longer imprisoned within the Mellahs, but live free to work for the country's material prosperity, untrammelled by the limitations under which they laboured of yore and even now chafe under in the unoccupied regions of the empire. The value of their co-operation is well understood by the Spanish Government and population, of whose support they can always be assured.

(*To be continued.*)

GEOGRAPHICAL RECONNAISSANCE BY AEROPLANE PHOTOGRAPHY, WITH SPECIAL REFERENCE TO THE WORK DONE ON THE PALESTINE FRONT

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THE development of aerial photography during the War resulted in a system by which the results of a rapid reconnaissance of a large tract of country could be expressed in a graphical form. Such results become of geographical interest when it is possible to convert them into maps or charts, and consequently we have to consider both the methods

of obtaining suitable photographic information over a wide area and the work of compiling from it reconnaissance maps of the area.

The subject under consideration is allied to the question of map-making from aeroplane photographs, but it is on a different footing, for our underlying idea is the execution of a general reconnaissance survey of a region leading to the construction of the best possible map on a scale of about 1 inch to the mile, or perhaps 1 : 40,000. Our methods must be rapid and easy, and will consequently differ from those employed with the object of mapping every feature of the surface of the ground in its exactly correct position. If we wish to deal with local features such as towns or ruins on a more detailed scale, we shall have to be content with relative accuracy of position in the locality, but in our small-scale maps we shall aim at a degree of accuracy which is not much less than that usually attained in such productions.

It will be convenient to divide the materials to be brought forward into two classes, under the following headings. (A) The experience gained on the Palestine Front, where the author was employed during the latter half of the war. (B) The examination of the methods employed in this region and the consideration of their applicability to other areas.

The methods of mapping from aeroplane photographs on the Western Front have been already described by Colonel MacLeod (*G.J.*, vol. 53, p. 382, June 1919), and it will be seen that those which are here described are considerably different. The methods developed in the East were quite independently worked out and are based on the taking of special photographs in a particular way, rather than on the utilization of any photographical material which the Air Force could obtain. It may be useful, therefore, to notice at the outset some of the causes which contributed to this divergence of method. In the first place, the conditions of aerial activity in France were very unfavourable for mapping photography. Straight flying and the production of long series of photographs were virtually impossible. On the other hand, the Palestine system postulated the unhampered activity of the airman and the close co-operation of the personnel of the Air Force and Survey Company. Again in the East the area to be photographed by a single Air Force unit was much greater than in the West, and economy in time, aircraft, and material had to be closely studied; and this encouraged the employment of methods which were perhaps somewhat less refined. In the East, also, the accuracy of position which was possible in the final maps was never so great as that achieved or required on the Western Front, but the shape of the ground was of the utmost importance. It is not therefore surprising that the two systems as finally established showed many points of difference. It is unwise to conclude that one system is better than the other, while the assumption that the system employed on the Western Front is naturally the better for future use, is unwarranted.

Aerial Survey in Sinai and Palestine. A. Development of a Method.

The possibility of using aeroplane photographs in the production of maps was investigated in Egypt during 1915 under the direction of Mr. E. M. Dowson, at that time Director of the Survey of Egypt, and the results obtained were utilized in connection with the operations in Gallipoli. The underlying principles of the work, together with the difficulties to be met and the precautions to be taken, were made clear in these investigations, which may be regarded as the foundation of the system used in the East.

During 1916 some small amount of work was carried out in the Suez Canal zone, but during the advance of the army into Sinai the method fell into abeyance. In Sinai the existing maps were not sufficiently detailed to allow of the location of the photographs taken, and it was seldom that photo-groups could be scaled from the map. Moreover, the advance of our troops was rapid and the need for detailed maps was not greatly felt. During this period, however, some work was done in the production of photo-mosaics of selected areas, and valuable lessons were learned from these. It was found that photographs which were intended to be truly vertical were often considerably distorted owing to the optical axis of the camera being tilted at the moment of exposure. On the other hand, it appeared that if the camera was rigidly mounted on the machine and carefully levelled, and if the pilot was flying on a straight course, the distortion was much less. Better results were obtained by covering an area by a series of strips of consecutive photographs than could be got by the practice of taking separate views of a number of adjacent points in no regular order (often known as pin-pointing). This led to the initiation of the strip system.

By the end of 1916 a considerable advance had been made. A good town map of Gaza was produced from a series of parallel strips of photographs, and a MS. sketch-map of Rafa, produced from intersecting strips, was very useful in the battle at that place. The lack of points on the map which could be identified on the photographs led to the taking of several long series of 50 to 70 overlapping exposures which were invaluable for placing subsequent prints or series.

When the Turks made a stand on the Gaza–Beersheba line and commenced to dig systems of trenches, mapping by aerial photography became of great importance. The pre-war maps were quite inadequate for trench warefare, and a new series of maps on scales of 1/40,000 and 1/20,000 had to be constructed, sometimes entirely from photographic material. The whole area occupied by the enemy's troops and a considerable extent of country to his rear, especially along the roads and railways, was photographed. The photographs were taken in intersecting series, some along the front, some extending from our lines into the enemy's territory, and these were built up into maps upon a meagre framework of points fixed in our lines, or located by intersections from

our territory. A few points were furnished by the older maps, but these had to be used with caution. The results were on the whole successful and were very favourably received, valuable lessons were learned, and confidence was gained by all concerned in the map production. Some 400 square miles of country were mapped from photographs, and since during much of the period the German aviators had markedly superior machines, our progress owed much to the skill and daring of our R.F.C. pilots. By October 1917 a system of photography and map compilation had been arrived at, which held in essentials to the end of the war.

This historical summary has been given in order that it may be understood how the work in Palestine commenced. The need for maps on a scale of about 1/40,000 was keenly felt; little help was forthcoming from previous surveys; and everything depended on the way in which photography was carried out and the photographs used. Consequently the question had to be studied from every point of view. The relations of points shown on vertical or tilted photographs to their positions in plan were worked out. The ability of pilots to fly level and to take approximately vertical views was studied. The relations of prints in a series and the possibilities of recording tilt were worked at. I should like to mention the names of Messrs. T. L. Bennett and W. H. Douglas of the Survey of Egypt, and of Lieut. N. Shiels (Australian R.E.) and Captain F. S. Richards in connection with these investigations. It should be understood that during 1918, when we were concentrating on the work of producing undistorted pictures of the ground, we fully realized the occurrence and effects of tilt, but aimed at its elimination rather than at its correction.

The Work in Central Palestine.

At the beginning of 1918 we were much better off for personnel and equipment. We had Bristol Fighters which could easily attain heights of 10,000 to 20,000 feet, cameras were more up to date, and lenses more suitable. More photographs could be taken and dealt with, and it was possible to arrange for one flight of No. 1 Squadron A.F.C. to specialize on mapping photography. The Central Palestine hill country was more difficult ground to deal with, but it possesses many villages whose positions were accurately shown on the 1 inch to the mile map from the survey of Kitchener and Conder, giving a framework of fixed points on which the photographic material could be fitted.

In the district to the east of Jordan, however, the old difficulties were encountered; the old maps were very incomplete and often inaccurate; the number of fixed points was very small; and, in addition, the country was very mountainous. As the result of photography a tolerably good reconnaissance map was produced, showing the wadis, hills, roads and tracks with a moderate degree of accuracy of position. The results showed, when some tests were made, that considerable progress had been

made in the elaboration of a system which would give useful results under very unfavourable conditions. The progress made is indicated by the fact that whereas the area mapped on the Gaza–Beersheba front was 400 square miles, subsequent work up to the time of the armistice brought the area up to about 2000 square miles, of which about 1500 square miles was photographed by a C Flight, No. 1 Sq. A.F.C. The country was completely photographed to a depth of about 25 miles behind the Turkish lines, and, in addition, the roads and railways leading northwards out of this area were dealt with.

Methods employed.

The photographic work of the Palestine Brigade R.A.F. was divided into two distinct portions: (*a*) Topographical work on a small scale under the best possible conditions for general mapping; (*b*) Intelligence work on trench systems, enemy battery areas, etc., which could, if desired, be incorporated in the maps produced as the results of the former work. The machines carrying out this work were usually at low or moderate altitudes, often under heavy anti-aircraft fire, and were given a good deal of latitude as regards overlapping and straight flying. The topographical photography was kept well ahead, and the country was usually photographed before trench systems and A.A. defences had been established; we shall henceforward deal exclusively with this division of the work.

The great majority of the plates were exposed in a camera of the L type fixed in a machine with its optical axis vertical and the plate horizontal. Before dealing with an area, a consultation was held between the officers of the Survey Company and the Royal Air Force at which the general scheme of work was determined. The area was then roughly marked out in a series of strips showing the ground which should be covered by each machine. The arrangement of these strips usually depended on the contours of the country, but the positions of fixed points, easily observable landmarks, and previous work were also taken into account. Most of the strips would be parallel, but some of them would be arranged to intersect the others for the purpose of tying down any series which failed to overlap laterally, and for assisting in determinations of the scale (see Fig. 1). Diagrams or maps were then prepared for the use of the pilots, showing them the course to be followed, and often amplified by the addition of previous oblique views (panoramic views taken with the optical axis of the camera tilted at an angle of 70° to 80° to the vertical, or with an equivalent prism attachment) or other photographs. In making the final arrangements it was often necessary to take into account the direction of the wind at the required altitude. The camera was mounted in a specially constructed semi-rigid pivoted fitting, which could be adjusted in a fore-and-aft direction so as to bring the plate into a horizontal position which was indicated by a spirit level. This arrangement proved a satisfactory solution for the difficulty of ascertaining the flying position of the fuselage

in order to level the camera, because the variation of the incidence of the tail plane in machines like the Bristol Fighter introduces a considerable variation in air speed during flight and consequently in the fore-and-aft level of the fuselage. The pilot was now free to adjust his flying speed as desired, and had only to keep his wings level and his height constant. Considerable trouble was experienced in obtaining comparatively undistorted photographs before the introduction of this fitting, and though it was roughly made it gave valuable results (see below, p. 360).

In the air the pilot had to concentrate on finding his course and on keeping his machine level, while the observer manipulated the camera. The fitting was first levelled, and then exposures were made at the required intervals either by reference to a sight or by time, or usually by a combination of both methods. After eighteen exposures the plate boxes had to be expeditiously changed so as not to break the sequence of the overlap, and the work was continued until a series had been secured covering the required area of from 5 to 10 miles—or in some cases as much as 35 miles. The pilot would then turn and a second strip would be photographed, and so on until the task was completed and from seventy-two to one hundred and eight plates had been exposed. Often two and sometimes as many as five machines would work together under an escort, so that a very large area was covered in a single morning (see Fig. 1). Most of the work was done from heights of 10,000 to 15,000 feet, but in hilly country with longer-focus lenses greater heights were often employed. It was not found very practicable to use prints which had a much smaller scale than 1 : 20,000, and with 6-inch lens this limited the height to 10,000 feet.

On returning to the aerodrome the plates were quickly developed and unglazed contact prints were made, together with a set of enlargements. These were handed over to the Field Survey Company. It may be useful to point out here that if prints are glazed their utility for map-making is entirely destroyed. The resulting image is always larger than the original negative image owing to the expansion of the paper, and this expansion is greater in one direction than in another. The enlargements are often very useful for reference during compilation and after the contacts have been stuck down and inked up.

We now pass on to the work of the Survey officer who is to compile the map. After a preliminary examination and identification of the areas which have actually been covered, he sorts out the prints into sets or strips each comprising from ten to twenty prints. Each set would usually contain at least two fixed points, preferably near either end, from which the scale of the whole could be determined. Each print in the set should overlap its neighbours by from 30 to 40 per cent., and the same points on adjacent photographs should overlap accurately. If the overlaps were bad and indicated distortion, the series was usually rejected and a new set had to be taken on another day.

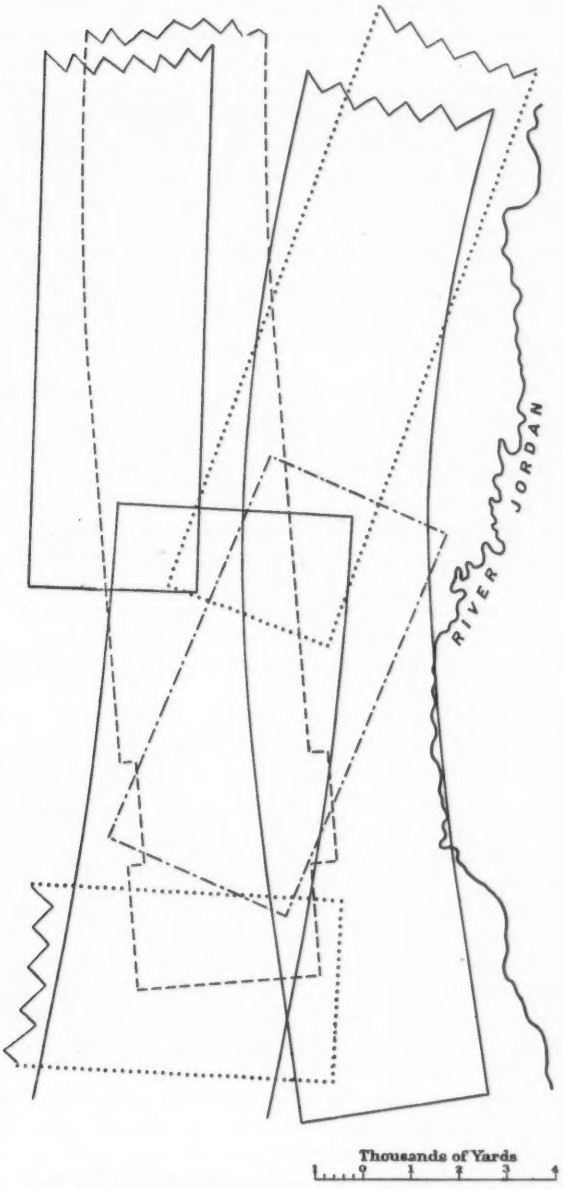


Fig. 1.—Results of attempt to cover ground with parallel strips of photographs

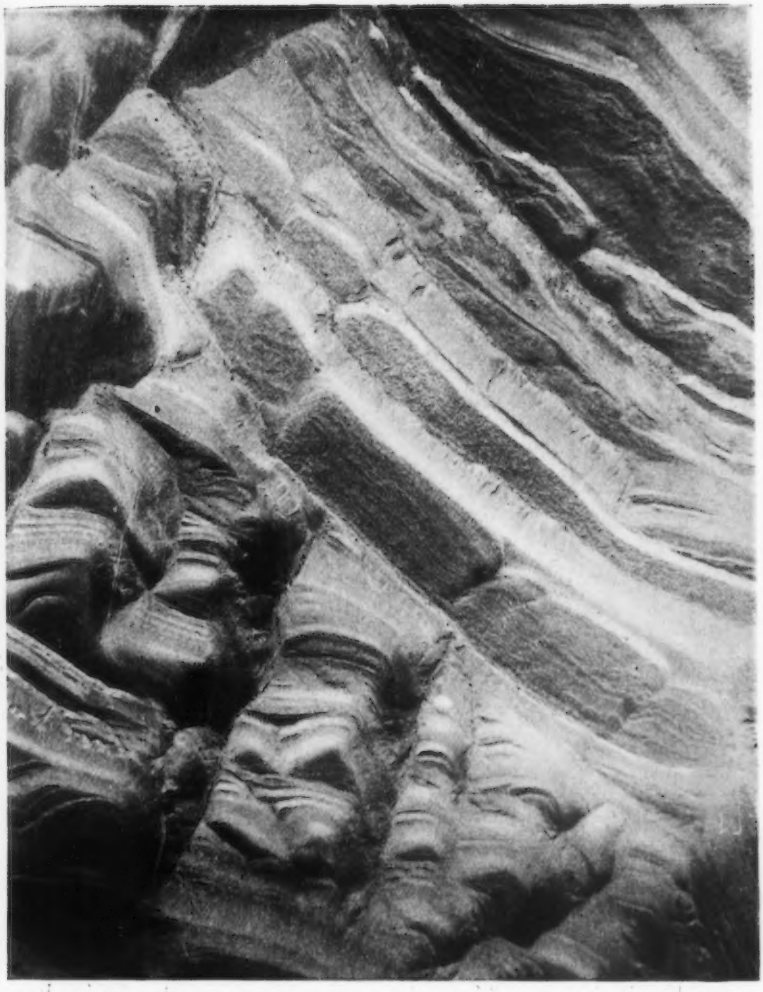
The photographs were then pinned down on a large piece of cardboard in their correct relative positions, so that points on one print fitted with those on the next. Any trimming required was done, and eventually the series was gummed on to the card, care being taken that in adjusting the position of the print, points were used which appeared to be on the same altitude and not too near the edges of the picture. The group of prints thus obtained was used as a unit in the map compilation.

All possible points which could be identified on the old map and seemed reliable, or which had been fixed by intersection, were then noted, and by using combinations of these the scale of the group was determined. Several values would usually be obtained for the scale, and if they agreed fairly well a weighted mean value was taken. If the ground depicted changed considerably in altitude throughout the series, special treatment was needed.

The group was then inked up, everything which was to appear on the final map being overlined with transparent coloured ink of an appropriate colour, after which the inked detail was pantographed down to the map scale on a piece of tracing linen. Eidographs by Elliot were chiefly used in this work, and were found to be more convenient than the system of reduction by photography which was used in Mesopotamia. A series of points, such as bushes, rocks, or road junctions, which could be clearly picked out on other series, was also marked, and was later used in fitting together all the material available. In this way all the photographic material was eventually reduced to series of strips drawn on tracing linen to approximately the same scale, and showing everything which was to be included in the final map.

In compiling the map from this material a large sheet of tracing linen was prepared and ruled up with the usual 1000-yard squares. All points which could be fixed by reference to previous surveys or from work done within our lines, were then inserted, and the edges of adjacent completed sheets were also traced on. This served as the framework upon which the rest of the detail was built up.

The next step was to plot a number of secondary points on the sheet by reference to the primary points and the photographic detail, so as to have fixed points every 3000 yards. A pantographed strip was placed in position by reference to the primary points, and the location of some small prominent object seen in the photographs was ascertained. This object would be shown in several strips or groups, and from each of them an independent value for its position would be obtained. A weighted mean position would be taken, and repeating the process for other objects, the sheet was covered with points whose mean positions had been ascertained. The strips of detail were then placed below the sheet, adjusted with reference to the primary and secondary fixed points, and the detail traced in from them. In this way every group was slightly adjusted and errors in scale or azimuth, which may have arisen in the photographs, were distributed, so



MOUNTAINS OF SINAI NEAR MAGHARA: VERTICAL AIR-PHOTOGRAPH SHOWING EFFECT OF HARD ROCKS ON SURFACE CONFIGURATION OF DESERT

OBLIQUE AIR-PHOTOGRAPH OVER TURKISH FRONT LINE: HILL COUNTRY IN EAST-CENTRAL PALESTINE. TOPOGRAPHY MAPPED FROM AIR, USING VILLAGES (AS IN FOREGROUND RIGHT) AS FIXED POINTS

that no single photograph or group had to be distorted violently, as sometimes happens owing to an accumulation of errors when constructing mosaics. When two values of secondary fitting points were rather far apart, as happens in pictures of steep hilly country taken along the

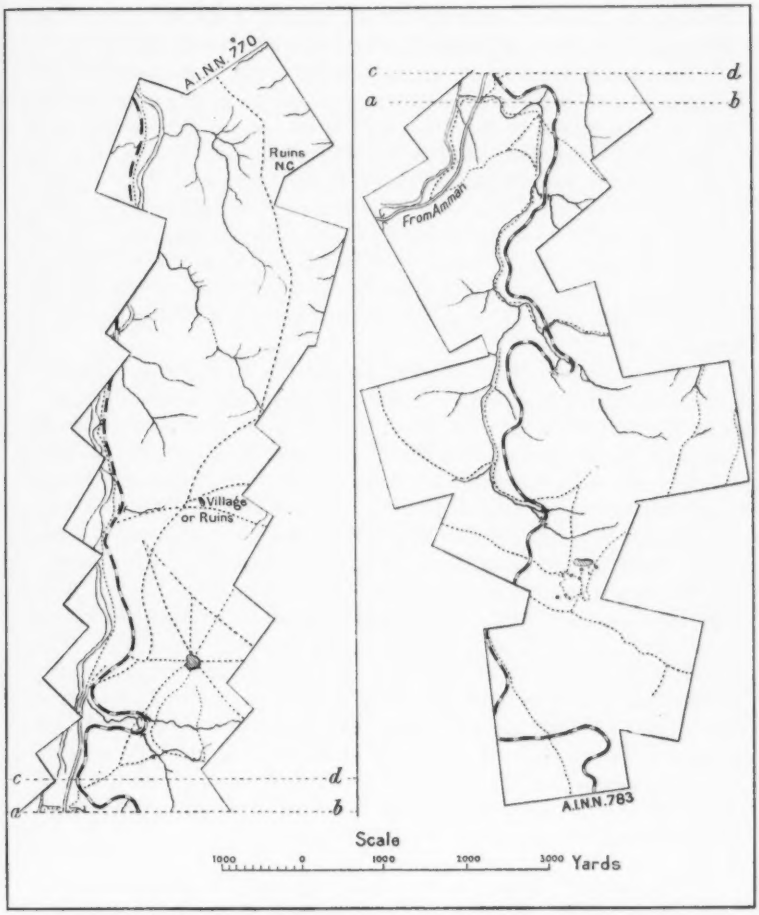


Fig. 2.—Example of reconnaissance map worked up from a strip of overlapping photographs

contours, a special method of adding the detail square by square in its approximately correct position was adopted.

Form lines were added to all the later maps, and these were based on the stereoscopic examination of adjacent prints. When the adjacent

photographs in a series overlap by 50 per cent., the whole of the area covered can be viewed stereoscopically. If A and B are two consecutive prints, the ground seen on the right-hand side of A is shown on the left-hand side of B, and the stereoscopic base is the distance between the centres of A and B. When the prints are placed side by side and viewed through a stereoscope so that the left eye looks at A and the right eye at B, the relief of the common area is clearly seen after a little adjustment.

The amount of relief seen depends on the height of the camera from the ground and on the length of the stereoscopic base. By inspection in this way the shapes of the hills and valleys can be determined, and indicated by form lines inked in on the prints. These lines can be reduced by the pantograph and shown in the final map. This method gives some idea of the relative heights, and further valuable information can be obtained from oblique views also taken in stereoscopic pairs. These enable the worker to determine which points in a ridge are the highest and lowest. More exact determinations of relief or the estimations of actual contours were not attempted, though methods for doing this were studied.

In concluding this brief sketch of the methods employed in Palestine some remarks may be added as to the degree of accuracy obtained. Capt. F. S. Richards, of the 7th Field Survey Company and the Survey of Egypt, has gone into this question and states: (1) Where the ground was flat and triangulated points close together great accuracy was obtained. Every point was within 40 metres of its correct position and the detail of wadis, roads, fields, etc., was more accurate than ground plane-table survey work done under military conditions. No slopes however can be shown. (2) Where triangulated points are fairly close (an average of four in a square of 6000 yards sides) and the ground hilly, as in Central Palestine, the maximum error of position of any point is about 200 metres. The shapes of the hills and wadis would again be better than in an ordinary military plane-table survey.* (3) Some sheets were constructed on a very much smaller number of fixed points; in one case only six occurred in a sheet covering 20,000 yards by 28,000 yards, and here again the country was mountainous. In these a maximum error of about 400 metres is to be feared in parts; the general shape of the detail is again good, though its position may be inaccurate.

B. The method which has been described seems to be applicable to the work of geographical reconnaissance in other areas. It possesses the advantages of requiring a comparatively small amount of basal survey work on the ground; it is rapid, enabling large areas to be covered to a considerable distance from the landing grounds; and it does not entail an unduly great labour in the work of compilation. With a moderate

* That is in a country to which access is difficult, and in which a considerable rate of progress is required by the circumstances.

number of fixed points and in suitable country, it gives results which are as accurate as are usually obtained in maps on a scale of about 1 inch to the mile, and makes it possible to show the exact shape of the detail without trouble.

We may, however, examine further some of the general ideas underlying this system and notice the types of country in which it is suitable, dealing briefly with the lines along which improvements may be made in the future.

Limits of the Utility of Vertical Photographs.

When a photograph of perfectly level ground is taken on an accurately levelled plate with a modern camera whose optical axis is vertical, the resulting plate depicts the ground accurately in plan. Distortion due to the aberration of the lens is quite negligible with a good modern anastigmat such as is usually employed in an aeroplane camera. The error due to the movement of the aeroplane during the travel of the focal-plane blind is negligible at moderate heights and in the case of photographs of a scale of about 1 : 20,000, but the replacement of the focal plane shutter by a between-lens shutter might be thought of.

In practice, however, the ground may not be flat or the plate horizontal; but in our system the plate is regarded as being so nearly horizontal that the difference from the true representation is small, and does not produce appreciable errors in maps on a scale of 1 : 40,000. We also assume that it is possible for a pilot to take a series of vertical photographs while keeping his height virtually constant. The grounds for these assumptions must be examined more closely owing to the divergent views which are held on the subject.

It is stated by workers on other fronts that experience shows that aeroplane photographs are always more or less distorted owing to the plate not being horizontal at the moment of exposure, and if this be the case it is due to one or more of the following causes: (1) The way in which the machine is rigged or flown; (2) The atmospheric conditions; (3) The mounting of the camera in the machine. Suitable photographs cannot be obtained unless attention is paid to all these points.

Pilots usually need training and practice in flying level. On the French front straight flying and consequently level flying was very unwise and unsafe, on account of the enemy anti-aircraft defences, but in the East after training and practice good work was done without special instruments. Experiments made in England during the last two years in connection with aerial navigation similarly indicate that considerable accuracy of position can be maintained. This is increased by the use of special instruments for detecting turning movements and change of altitude.

Atmospheric conditions are often responsible for irregularities in the position of the optical axis of the camera. At low elevations, differences

in the density of the air or other causes, give rise to the phenomena known as "bumps," and cause either the sudden fall of the whole machine or the tipping up of one plane. These effects, however, greatly decrease with an increase in height, and at altitudes of about 10,000 feet they disappear, and a perfectly steady wind is experienced, except in certain rare cases. This is an important reason for carrying out survey photography from a considerable height and for using long-focus lenses when larger-scale photographs are required.

The mounting of the camera in the aeroplane is one of the chief causes of distortion due to tilt, but it is also necessary to ensure that the lens is accurately mounted in the camera itself. It is obviously impossible to obtain correct photographs unless the plate is horizontal when the machine is in its level flying position. During the war little attention was given to this aspect of camera mounting, the greater care being paid to devices for the elimination of vibration effects, and consequently the optical axis of the camera was often three or four degrees from the vertical even when the machine was flying straight. Except in Palestine, it was seldom recognized that the level of the fuselage varies with the air speed of the machine, but when the incidence of the tail plane can be adjusted, the air speed may alter considerably, and this may result in the plate being tilted from five to ten degrees out of the horizontal. We found that this was a great source of error when using Bristol Fighters, and, as mentioned above, a special swinging fitting was designed to meet the case. With this mounting the camera could be brought into a horizontal position whatever the slope of the fuselage, and the results gave considerable satisfaction even though the adjustment was made by reference to a spirit level.

It had been argued that a spirit level would not give accurate results in the air owing to changes in the acceleration of the machine, and therefore such an arrangement was only used as a last resource. All recent work, however, indicates that the argument against the use of gravity levels in steadily flown machines, is fallacious. A considerable body of evidence has been collected recently on the accuracy of gravity levels in aeroplanes. Many trials have been made in England and America with both pendulum and bubble levels in connection with sextant observations. As the result of a very long series of observations made with bubble instruments the average deviation from the horizontal of single readings proved to be no more that $\pm 2'$. These experiments seem to show that it should be possible to mount a camera and to fly a machine in such a way that the optical axis of the camera is never more than half a degree from the vertical at the instant of exposure.

The question of recording the tilt of the camera was considered some time ago, but the difficulty of producing a small and sensitive tilt detector proved insuperable at the time. Messrs. Bennett and Douglas of the Egyptian Survey conceived the system of photographing the horizon at

the moment of exposure with two small auxiliary lenses; in practice, however, the horizon was found to be too indistinct to be of practical utility. The German tilt recorders of Zeiss were very neat, but were probably not capable of sufficient accuracy.

The question of maintaining the camera in a vertical position by means of a gyroscopic stabilizer was suggested some time ago, and a considerable amount of experimental work was latterly done on this subject. It cannot, however, be said that the results yet achieved have been entirely satisfactory.

The Magnitude of Errors due to Tilt.

I have not yet had the opportunity of comparing closely a good set of photographs with a carefully surveyed map of the ground which they

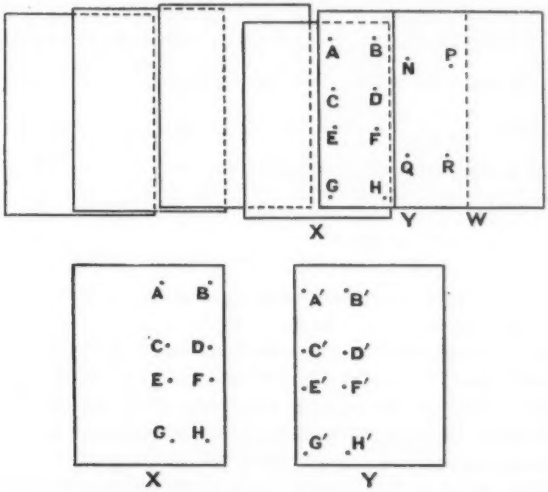


Fig. 3.—Test of errors due to tilt

represent, and some comparisons that have been already made by others are open to criticism. We may, however, gain some idea of the magnitude and relative importance of distortions due to tilt by the examination of a series of well-overlapped prints. Let X and Y be two adjacent prints in a series which overlap by 50 per cent. (see Fig. 3), and let A, B, C, D, E, F, G, H be points on the ground which are shown in both prints. If the ground is flat and the photographs undistorted the distance between any pair of points measured on either print will be the same, and each print will give a true representation of the ground in plan. If however one or both prints are distorted, the distance between a pair of points will be apparently greater as measured from one of the prints than it appears to be from the other, except when the amount of distortion

of Y is equal in amount but opposite in direction to that of X. It is probable, however, that if X and Y are distorted, the distortion will be in the same direction in both. If this is the case and AB, A′B′, etc., represent the actual distances as measured from the prints, then AB may be greater that A′B′ and AG greater than A′G′. Now it can be shown that the positions of points near the centre of the plate or the axis of tilt are very little affected by even a tilt of several degrees. Thus if the tilt is in the vertical plane through the line of flight, the distances AC, CE, CG, etc., will show the relationship to their corresponding distances on the ground according to the equation

$$\text{Distance on print} = \frac{\text{distance on ground} \times \text{focal length of lens}}{\text{height of aeroplane}}$$

This relation, however, will not be correct for such points on the margin of the other print as A′C′, C′E′ or C′G′, and a rough measure of the amount of distortion will be given by the ratio $\frac{AG - A'G'}{A'G'}$, which should be equal to $\frac{B'H' - BH}{BH}$. On the other hand, if X and Y are both distorted in the same direction and by the same amount, AB will be too large, A′B′ too small, and the ratio $\frac{AB - A'B'}{A'B'}$ should be more than double that of $\frac{B'H' - BH}{BH}$, that is, the distortion shown by comparing adjacent prints appears greater in the plane of the tilt than in the direction at right angles to it.

I have endeavoured to apply this method of study to a few prints which were brought back from Palestine for other purposes. One pair of photographs showed flat country, while five other pairs belonged to a series covering about 35 miles in northern Palestine and showing somewhat broken country of approximately the same general elevation. A preliminary study of this material may be worth recording as showing the magnitude of the ratios referred to above; the differences to be measured were, however, so small that more refined methods and apparatus are required, and it is hoped to make a more detailed and careful study at a later date. The larger series was first investigated by using a pair of dividers and a millimetre scale. A number of points were chosen which seemed to lie at the same elevation, and the following ratios were obtained:

$$\frac{B'H' - BH}{BH} = \cdot 43 \text{ per cent.} \qquad \frac{AB - A'B'}{A'B'} = 1 \cdot 6 \text{ per cent.}$$

But the quantities B′H′ − BH were too small for this rough method, and an apparatus was tried consisting of a fixed microscope with pointer eyepiece and a travelling microscope actuated by a micrometer screw graduated in hundredths of a millimetre. Some of the readings with this

method are given below, and the results are of the same order as those already quoted, viz. $\frac{B'H' - BH}{BH} = \cdot 44$ per cent. and $\frac{AB - A'B'}{A'B'} = 1 \cdot 04$ per cent. In the case of the prints showing flat ground, the first ratio was only ·31 per cent., but the overlap of these prints was not very regular nor was the definition good enough for the high magnifying power of the microscopes used.

Print nos.	BH*	B'H'−BH	$\frac{B'H'-BH}{BH}$	Average for pair.	A'B'*	AB−A'B'	$\frac{AB-A'B'}{A'B'}$	Average for pair.
	mm.	mm.	Per cent.	Per cent.	mm.	mm.	Per cent.	Per cent.
A1NN	96	·45	·47		44	·27	·61	
3431	105	·5	·47		37	·29	·78	
3432	102	·14	·14		41	·73	1·78	
	104	1·31	1·2	·57	42	·95	2·25	1·29
	(corners)				41	·43	1·04	
3430	53	·02	·03		43	·04	·09	
3431	107	·38	·35		50	·5	·1	
	101	·32	·32		41	·9	2·2	
	62	·06	·09	·19	50	·08	·16	·64
3435	85	·8	·94		55	·8	1·45	
3436	85	·45	·53		58	·5	·86	1·21
	84	·5	·59		62	·5	·8	
	80	·15	·19	·56	58 (corner)	1·0	1·72	

It must be noted that none of these results are strictly reliable because the prints used were all enlargements, and may possess an unknown error if the enlarging lantern was refocussed each time a print was made. It is unfortunate that suitable contact prints are not now available for study, but the experience of the survey officers in the field showed that the quantities investigated were negligible in practice, and little attention was given to the question until the freedom of such photographs from distortion was questioned.

The above measurements brought out another important fact, viz. that a much better result is obtained by discarding any points near the corners of the prints. Now when we have ample overlaps we can trim off the edges of the prints before sticking down, and so use only the parts which are fairly near the centre. This is not a wasteful process because the superabundant parts give useful material for our stereoscopic study of the contouring. It has been shown by M. Clerc (*British Journal of Photography*, vol. 66, p. 298; 1919) that in the case of a tilt of half a degree, the useful surface of a 13 × 18 cm. plate is 12 × 17 cms., and on this surface the error of definition is not greater than ·02 cm., which is equivalent to 2 metres on the ground in a photograph taken with a lens of 26 cms. focal length from a height of 2600 metres.

* The measurements are made between various points on the prints in a direction parallel to the lines BH and AB (see Fig. 3).

It may be further noted that if the exact positions on the ground of four points, *e.g. a, b, c, d*, are known, it should be possible to correct any distortion in the prints X and Y where these points are shown. Then taking four other points shown on the corrected Y (see Fig. 3), such as N, P, Q, R, which are shown on the next print of the series also, it should be possible to correct this by rephotographing, and so on. This method was suggested to me by Mr. T. L. Bennett in 1917 and was tried, but the differences in position of the points on successive prints were too small to be dealt with in the rough apparatus at my disposal. It is probably impracticable to try to correct distortions of the order of ·5 per cent. by this means.

In following our method there is no need to trouble about distortions which do not produce errors of scale greater than ·5 per cent., because when fitting together prints by means of points not more than 4 inches apart, a failure to overlap by one-fiftieth of an inch can be neglected, as it is scarcely possible to fit prints to closer than one-hundredth of an inch If the original prints have a scale of 1 : 20,000 and are used for a 1 : 40,000 map, the possible error is less than the thickness of a line.

The question of errors due to tilt has been dealt with at length, because it is of fundamental importance in our system. If practically undistorted prints can be obtained it greatly simplifies the work of mapping from aerial photographs, and makes the use of the strip system possible for reconnaissance work.

The results obtained in Palestine certainly seem to indicate that such photographs can be obtained even with roughly made camera fittings and without the use of turn indicators, but further experiments are desirable to settle the exact limits of what can be done under favourable circumstances.

The Ground suitable for Aerial Reconnaissance Surveys.

If the ground depicted in a photograph is not flat, but rises steeply on one side, its representation on a horizontal plate is not a true plan but becomes incorrect near the edges of the plate, and the greater the angle of view the greater will be the error. Consequently our system of mapping by aerial photography is more suitable for a flat than for a hilly country. If the height of the hills is small compared with the height of the aeroplane, a fairly useful result can be obtained by flying as high as possible and using a long-focus narrow-angle lens.

In Palestine the principal method of dealing with hilly country was to take series along the general line of the contours so that the scale throughout the series should be even, though it was constantly greater on one side of each photograph than on the other. This inequality in the scales of the two sides results in a group of prints taken on a straight course becoming curved when stuck down, and in a shift of the azimuths throughout. It is often however possible to subsequently straighten out

a curved group and correct the azimuths. This may be effected by (1) reference to points fixed trigonometrically, (2) comparison with adjoining photographs taken over flat ground, (3) reference to oblique photographs taken by another camera pointing in the direction of the line of flight. A well-known and useful property of oblique views is that straight lines on the ground also appear as straight lines in the photograph, so that by comparison of oblique and vertical views it is possible to plot series of points shown in the latter which lie in a straight line on the ground. A combination of these methods in Palestine enabled much steep hilly country to be dealt with and maps to be produced which gave a good representation of the ground, though not very accurate as regards the geographical position of detail.

It does not seem likely that the present method of photography on horizontal plates will be suitable without profound modifications for the treatment of high mountain areas such as those on the frontiers of India. Here however a system of oblique photography may be employed, which would be worked on similar lines to some of the methods of photogrammetry used for ground surveys.

The areas in which our methods will be most useful are those where the country is flat, but much enclosed or possessing numerous trees and hedges. In such country ground survey is slow owing to the large number of stations which have to be occupied, but air-survey is rapid and accurate. Similarly in fairly flat but very broken country in semi-arid regions—bad-land topography of the American terminology—the detail is often too complicated for survey on the ground and travelling is slow, while the air photograph shows all the detail, and as much as is required can be placed on the map.

A subject which must be also considered is the provision of landing grounds for the aeroplane. It will not be possible to use the aerial method of survey in many regions covered with tropical rain forest because of the lack of aerodromes or landing grounds, though in some regions, such as the Amazon basin, it would be possible to use sea-planes or flying boats. It must be remembered, however, that a modern machine has a radius of action of at least 100 miles, and with extra tanks and a peace-time load this radius may be further increased. In many of the less densely populated areas of the world it is not difficult to find open spaces which will serve as temporary landing grounds for a few days, and this is all that is likely to be required.

It is of some importance to consider to what extent aeroplane photography could be used over a country like Afghanistan which is difficult of access, comparatively little surveyed already, and mountainous. Here the present methods will enable us to do little more than produce a picture of parts of the country, or a rough sketch-plan showing a great deal of topographical detail, but having little accuracy as regards position except in the neighbourhood of a few points which have been already

fixed. But such a topographical picture would have very considerable value and would greatly assist in the work of future exploration and survey. The execution of such a task as this would involve close attention to another factor which we have hitherto passed unnoticed, that is the estimation of the height of the aeroplane above the ground.

Determination of the Height of the Camera.

If the plate is horizontal and the height of the aeroplane from the ground is known, it is theoretically possible to carry out a considerable amount of rough mapping without references to fixed points on the ground from which the scale of the photographs can be determined. The accurate measurement of the height of the machine from the ground is, however, a matter of difficulty at the present time. It has not been found possible to rely upon aneroid readings, though if the instruments were carefully calibrated and temperature corrections applied, we should probably obtain a satisfactory value for the altitude of the machine above sea-level; but even then the height of the ground is usually unknown. There are, however, methods which might be used to determine the height of the aeroplane from the ground and which are worthy of future investigation; some of these may be briefly mentioned.

The optical range-finding method may be used, by fitting small cameras near the ends of the wings and making simultaneous exposures by an electrical release. As the wings are not perfectly rigid an optical arrangement would have to be added to show the mutual relations of the cameras at the instant of exposure, but the difficulties of constructing a suitable apparatus do not seem to be insuperable. A separation of about 30 feet between the cameras would probably give good results up to a height of 12,000 feet from the ground.

Another method involves the use of two aeroplanes, each carrying a camera. One of them would fly about 500 feet above the other, and both would photograph the ground below. The upper machine would always include in its views a picture of the lower machine, and by the measurement of this image the difference in height of the two cameras could be ascertained; knowing the difference in height, we have only to compare the relative lengths between two objects shown on the ground in the upper and lower photographs to determine the heights of both cameras above the ground.

A third method which has been suggested is the automatic exposure of the plates carried by one machine at fixed time intervals, and the calculation of the ground speed of the aeroplane. This again gives a rough method for calculating the length of what may be termed the stereoscopic base from which the measurement of distances on successive prints gives the range to the ground.

These methods all depend on the plates being horizontal; but if the required conditions are fulfilled, we can plot the positions on the ground

of detail shown on the photographs from the height and optical constants alone. In addition to this, we become independent of the shape of the ground, and can work out heights of hills from stereo-pairs of prints and plot their positions more or less correctly. But we shall no more be able to attain accuracy over a large area than can be done by a plane-table topographical survey uncontrolled by a trigonometrical survey.

The Development of Stereoscopic Methods.

Reference has been made above to the application of stereoscopic methods for determining contours, and some notes may now be added as to probable development of this line of work. Two methods have been hitherto suggested for the use of pairs of prints showing the same area of ground from different points along the line of flight of the machine, but neither has yet been developed up to the point of ready practical application.

The system of stereo photo-surveying described by the late Colonel F. Vivian Thompson in the *Geographical Journal* for 1908 is applicable with some modifications to air photography. It may be seen by reference to this paper (p. 541) that if certain conditions are fulfilled, similar results may be obtained from horizontal plates in the air to those obtained from vertical plates on the ground.

The conditions to be attained are that our two photographs must be accurately parallel to each other and horizontal, and that the distance between their centres, *i.e.* the stereoscopic base, must be known. If the scale of the prints or the height of the aeroplane above any part of the ground is known, the length of the stereoscopic base can be calculated. The details of the Thompson stereo-comparator would have to be altered to allow for variations in the length of the stereoscopic base, but the principle of the instrument could be employed. Without going into the question in great detail, it may be mentioned that preliminary observations seem to indicate that we have here a method of great utility, and by its means very accurate form-lining can be accomplished even if fairly reliable determinations of height and contouring are not possible to the same degree of accuracy as can be achieved on the ground.

A second method has been studied by Squadron-Leader Burchall, O.B.E., of the R.A.F. School of Photography. The underlying principle is the comparison of the apparent height of an object seen in a stereo-pair of prints with the apparent height of a pair of lines engraved on glass, placed in contact with the prints and capable of movement by a fine micrometer screw, the prints and lines being viewed simultaneously through a stereoscope. This method is a modification of a French method devised by Commandant Coradin, and requires a knowledge of the height of the aeroplane and the length of the stereoscopic base.

The impression gained from the work in Palestine, where only the most unrefined form of stereoscopic examination was used, points to

the immense value of the utilization of stereoscopy in aerial photo-reconnaissance work. We again depend, however, on the production of views which show no appreciable distortion owing to tilt, though very small tilts do not seem to noticeably alter the form of the country.

The Relation of Photographic Work to Ground Survey.

In the preceding sections we have dealt with some considerations which might facilitate the production of sketch-maps in a country which was poor in triangulated points, but the indispensability of a good trigonometrical survey even for the production of reconnaissance maps must be again emphasized. Some recent writers seem to be unaware of the fact that while aeroplane photography can be used as a method of topographical survey, it cannot be used as a method of trigonometrical survey. It scarcely seems possible that aerial work will ever be independent of ground work, and the closer the net of fixed points on the ground the more accurate will be the map produced by aerial photography.

The important question is therefore, what must be the size of triangles in the ground framework to allow the photographic method to be usefully employed? The answer will depend upon the nature of the country and the accuracy of position required. In flat country excellent results will be obtained if fixed points occur at intervals of about every mile, and in small-scaled maps the separation of points by 3 or 4 miles should not introduce inaccuracies greater than those which may be caused by the expansion or contraction of paper or tracing paper during the preparation of the sheets. Again, if we merely require a reconnaissance map to show the principal features, such as roads, rivers, villages and woods in their correct *relative* position, even though their *geographical* position is incorrect by half a mile or so, the distances between our fixed points may be extended to from 5 to 8 miles. So much, however, depends on the country that generalizations are difficult. In Palestine we had to work in both flat and hilly country, but in both regions the photographic methods did provide a means of making useful reconnaissance maps in a short time with a comparatively open network of triangulated points.

When reconnaissance surveys on the ground have to cover wide areas, time does not usually allow the surveyor to draw in small local details accurately, but generalization or omission have to be resorted to. In the case of photography, however, it is possible to trace the detail in its correct shape and to add without trouble many small local features, such as small tributary streams, groups of trees, patches of rock, etc., which will make the map very valuable for subsequent use on the ground. A single aeroplane can photograph 30 square miles of country in a day within a radius of about 100 miles of its landing ground, and an air force unit of six machines (one flight) can cover at least 100 square miles a day and probably much more. Development and printing occupy only a short time, and the main labour is relegated to the compiling office.

In Palestine one officer without help could complete a 1:40,000 sheet covering 20,000 yards by 28,000 yards in six weeks, using perhaps 500 to 700 photographs. This method probably compares very favourably with other methods of map production as regards rapidity. When there is an existing trigonometrical survey, such as in India, we shall only need a ground party to traverse the area and collect information as to place-names, wells, etc., possibly fixing a few additional points also. This high rate of progress will probably render the aerial method an economical one, even taking into account the cost of upkeep of aeroplanes, and if Government aeroplanes maintained for other purposes are used for the work, it means cheapness as well as rapidity. If, however, aeroplanes or sea-planes and their equipment have to be transported long distances to the scenes of operation, it is possible that the method will not be economical unless the area is very large and difficult to survey on the ground. As, however, the air-routes become opened up over the world, the aeroplane or sea-plane survey will become much more practicable.

In this paper attention has been confined to the methods which have been already used with considerable success, and to the discussion of matters arising from them. Consequently nothing has been said about oblique photography and the methods of photogrammetry which may be applied to it. In the early days of the Palestine Campaign I devoted some attention to the question of using obliques for mapping, but found that it was likely to be slow and laborious. The taking and use of oblique photographs was subsequently simplified by the introduction of a prism attachment for the ordinary vertical camera; but we confined our use of obliques to the securing of a preliminary general reconnaissance of the ground before commencing vertical work, or additional information as to azimuths and relative heights. The oblique method of work has however some exponents, notably J. W. Bagley in America (*U.S. Geol. Surv. Bull.* 657, 1917). It probably has a future when applied to mountainous regions.

In dealing with reconnaissance work it must be remembered that sea-planes may be of great use to survey ships in coastal work, because in many places the reefs and shallows below the surface of the sea are clearly seen in photographs. In 1917 aeroplane photography was successfully used for charting the harbour of Rahbeg on the Arabian coast.

It would be too great a digression to describe the work of making town maps of the congested cities of the East, or the contemplated river surveys which are so much needed in the case of some Oriental rivers with unstable courses. At present the main field of activity in the East is in the production of reconnaissance maps of the type made in Palestine, which can be quickly and easily constructed, and which will be useful for both civil and military purposes. Those who have travelled in out-of-the-way regions and those who have at any time been engaged in military work, will realize

the great utility of maps which are sufficiently complete in local features to enable one to identify one's position by reference to the map detail. Most of the pre-war reconnaissance maps which I have used in the East, and which would be probably regarded as good of their type, involved the need of constantly stopping to take bearings on some distant known points in order to ascertain one's position, and this is a tiresome proceeding.

Some experiences in the field almost persuade one to put forward the thesis that in a reconnaissance map wealth of local detail and accuracy of relative position, by which the traveller knows exactly where he is and what features he is likely to meet, are to be preferred to a map which is poor in local detail even though the latitudes and longitudes are absolutely correct for those points which are shown. There is much to be said for this point of view, though it is perhaps scientifically unsound.

It is the full and detailed picture of the ground which can be so quickly and easily secured by aeroplane photography; and if methods are forthcoming of utilizing this picture to make a good small-scale map by an easy, rapid, and reliable method, then air photography will have an important future. If, however, the methods are slow and cumbrous they will only be useful in special emergencies.

The work already carried out in Palestine does seem to show that air photography possesses great advantages for reconnaissance work. The actual photography and mapping of 2000 square miles of country must be regarded as a real solid achievement rather than as an experiment. The methods may be criticized on theoretical grounds, but the results are the best answer to such criticism. Work on the same general lines has been successfully carried out in Egypt and Mesopotamia, which also shows that a practicable system has been attained from which much may be expected. Aerial photography must not, however, be applied to purposes for which it is unsuited; it can have no bearing on the geodetic side of survey work, and it is more suited for maps on a medium scale than for very large-scale maps or very small-scale maps.

The methods described have been elaborated by the close co-operation of surveyors with members of the Air Force, and it seems probable that further progress will only be made by the collaboration of the producers and users of air photographs. It is this belief which has prompted the author to contribute this paper.

Before the paper the PRESIDENT said: The lecturer this evening, Captain Hamshaw Thomas, was, before the war, more closely connected with the earth than with the air: a lecturer in Botany, and Fellow of Downing College, Cambridge. When the war broke out he joined the Air Force and has done some interesting reconnaissance work in Palestine. He will this evening give us the results of his experiences as to air photography. He will give us a different point of view from that which we heard last session—an account of air photography on the Western Front, which required very much more minute detail,

whereas Captain Thomas's reconnaissance work was of a more general kind. I have very much pleasure in introducing him to you and asking him to read his paper.

Captain Hamshaw Thomas then read the paper printed above, and a discussion followed.

Major-General Sir GEOFFREY SALMOND: I have been listening to a very interesting lecture. Captain Thomas was my photographic officer in the Middle East for a considerable period, and really the success of General Allenby's force was, to a very great degree, attributable to the work Captain Thomas did. I would like, as we have been talking about aerial photography, to just state a few details of how aerial photography first came into being. Aerial photography, although it seems a strange thing, is very closely linked in its origin with artillery work and wireless, because it was the necessity of squared maps and great detail for efficient artillery co-operation in the early days of the war in 1914, which made us go in for extreme accuracy and attempting to produce results from the air which otherwise we never should have attempted. Originally there was no method properly brought up to perfection of directing artillery fire with wireless, and the late Colonel D. S. Lewis, Royal Engineers, when we were on the Aisne, was the first officer who took this matter up, and taking the 80,000 map with which we were supplied in France, he squared that map in pencil and then made another map similarly squared, and gave it to a battery commander. This done he went out with his wireless machine and produced at once the most extraordinarily good results. The necessity of squared maps now became at once apparent, and when we moved up to Flanders squared maps were one of the first things with which we were supplied, and this was only brought about by the extraordinarily efficient and rapid manner in which the Map Department of the General Staff of G.H.Q. under Major Jack tackled the job. I always think we were indebted very much to his work in producing these squared maps, which became universal on the whole British front. About the same time that they were produced we tried to advance in aerial photography. The French, about October 1914, were getting forward, and sent our General Staff some results which at once made us feel we had something to learn, and we set about it, and in a very short time, thanks to the help of Sir Frederick Sykes and Sir Hugh Trenchard, we had a photographic section going with both wings in France, subsequently developing into a photographic section with each army, and then more than that later on. Directly our photographic work began to progress the tremendous advantage of having the squared system of mapping became apparent, because our trenches were accurately photographed and the results pleased everybody. The next thing that happened was, that our results were becoming so good that the photographic section of the photographic staff at R.A.F. headquarters approached the Survey Department G.H.Q. in order to further co-ordinate our work, and once that was done, from that day forward we never looked back. It is this very close co-operation between aerial photography and the survey department which, I believe, is one of the chief lessons to be learned as the result of the war as far as aerial photography is concerned. In Palestine we always used to put our headquarters as close to the Survey Headquarters as possible, in order that this very close liaison should be kept going. The task in Egypt was, as Captain Thomas has said, very different from that in France. In France we could take our aerial photographs and base them on an accurate map. In Egypt that was impossible, and in October 1915, when I went out to

Egypt, I found that whereas a certain amount of information trickled out to what we called the "side shows," about the development of aerial photography, yet no real policy had been adopted. For instance, in Salonika they had squared maps which were on a French basis—because the French were there first, or about the same time, and the British adopted their method. In Gallipoli we adopted a method of squared maps which was suggested by the navy. In Egypt no method had actually been adopted, and the result was, artillery pilots who went out to the Middle East found they had to learn a different system of signalling in every theatre, and it was owing to the disadvantages of having to learn these different things that it was decided to introduce a uniform system which was immediately applied into Mesopotamia, Egypt, Salonika and India, and that system was the same as we had in France. I should like to mention the work Captain Thomas has referred to of Mr. Dowson in Egypt. He has been the very greatest help to us and to Captain Thomas, I am sure, and to his staff in their work. As I said before, once we had got the principle of squared maps, aerial photography helped us to make more squares and helped in all sorts of directions. For instance, aerial photography in the war has done an enormous amount to save life. There is no question about that. Hostile trenches have been accurately photographed. Attacks that were to take place based on an air photograph taken a week ago, have been entirely altered twenty-four or twelve hours even, before the attack took place because a new feature, disclosed by a more recent photograph, had suddenly appeared in the enemy's defences. By such photographs the saving of life has been very great. Again, all these rehearsals of attacks that took place were based on plans which aerial photography supplied. The accurate shooting of hostile battery positions was largely due to aerial photography. As Captain Thomas knows very well, the capture of a place called Magdhaba, in Sinai, and the capture of Rafa were largely due to aerial photography. These places were completely reduced from the air by air photography, and they ought to have surrendered on that, but as a matter of fact, it was a gift to any army in so far as information went. Never before in history has an enemy been under such a disadvantage as they were at those places. There they were, building trenches as hard as they could and imagining we did not know where those trenches were, but before the attacks took place our General Staff had accurate squared maps and absolutely complete information regarding these particular positions at Magdhaba and Rafa. The result was they fell about twelve hours after the attack opened. At Beersheba, during General Allenby's attack on Gaza, Captain Thomas arranged for photographs of the defences round Beersheba to be taken every day, under General Borton's direction, who commanded the Palestine brigade. He arranged for the closest liaison with the Survey Department. The photographs were brought down in the morning from the aeroplanes; they were developed; the Survey Department took them over, and all the latest corrections were added to previously prepared maps; these maps were then photographed for rapidity of reproduction, and those photograph maps went out before the day was over to the troops who were moving up to the attack. Quite apart from all that, in General Allenby's great victory, I know I am right in saying that aerial photography was responsible, under Captain Thomas's direction, for discovering the various gorges through which the transport must pass, and the great tragedy of the Turkish retreat, commencing as it did from the right, where the transport with their guns, telephone and signalling gear, etc., was bombed to destruction by the Royal Air Force in the gorge at Tulkeram, followed up by more transport similarly caught in a gorge south of Jenin, followed up by

the eventual big retreat, where it was all decimated in another gorge about 15 miles north of Nablus, in which practically the whole of the enemy guns and transport were captured, was due enormously to the development of the highly efficient state of aerial photography of the Palestine Brigade, coupled with the able assistance of the Survey Department. The future uses of aerial photography are interesting. Already in India the Survey Department has formed a small aerial photographic and reconnaissance department of their own. They are photographing the high waters of the Sutlej in order to obtain some data which they wish for a very big scheme of electrification there. To do it by ordinary reconnaissance would take a very long time, but a squadron happens to be in the neighbourhood and are doing it. In Egypt the same thing is happening. The Nile recently has given a lot of trouble and there has been a good deal of leakage going on, and they asked the Royal Air Force to try and assist them. The work was done in an hour. It would have taken many days and would have cost a considerable sum of money if it had had to be done from the ground. In Mesopotamia flood boundaries, owing to the flooding of the Tigris, are accurately surveyed by the Royal Air Force. The estimation of crops is a big feature out there, and that is carried out by aerial photography—all in conection with the local Survey Department. But I think what this lecture seems to bring out so strongly is that aerial photography will simplify the task of survey work on the ground. It amplifies detail and assists ground parties to get their work done very much quicker than would have been possible in the past, and this is particularly the case in regions which are difficult for us to get at. The Cairo–Cape route, for instance, is now ready, and shortly will prove a practical air route. I should imagine that an enormous amount of work will be possible in connection with the Survey Departments of the various Governments on that route, by means of aerial photography. And just as Captain Thomas has pointed out how, in the past, it has been necessary to have these triangulated ground bases located by the Survey Department, in order to correctly apply the results of aerial photography, so, I think, for our development in the future, we have got to look back to what have been the foundations in the past, which have been the bed rock of our development. And what are these foundations? First of all, I think, it was the enthusiasm which inspired everybody to get the utmost efficiency out of the air. The second thing was the close co-operation between the Royal Air Force and the Survey Department. If we are to progress in the future we must maintain this enthusiasm. The war is over and the enthusiasm which the war inspired is over, but I think it rests with you, Sir, to keep that enthusiasm going in order that the co-operation which the Royal Air Force will give can be brought to its maximum through the various Survey Departments of the Empire.

Colonel Sir COOTE HEDLEY: I have not many remarks to make, because, what I had intended to say has already been said in Captain Thomas's lecture and by General Salmond. The particular point I wished to emphasize was that it is impossible to make maps merely by aeroplane photographs. Wherever you go, wherever you wish to make a map, you must enlist the services of the Survey Department in that place. The accuracy of the map which you ultimately will prepare will depend entirely, or almost entirely, on the number of fixed points you have on the ground, and fixed points involve a Survey Department to fix them. I am sure that all Survey Departments will be extremely pleased to have the services of any number of aeroplanes which can be lent them; but I do not think that they will, as a rule, be able to provide aeroplanes for their own use. The chances are it will be too expensive. But

when there are aeroplanes within reach they will be invaluable for the purposes General Salmond has already sketched and for many others also.

Colonel H. S. L. WINTERBOTHAM: Surely Captain Hamshaw Thomas is correct. It is to the East, and particularly to what was done in Palestine, that one must look for lessons in the combination of ground and aerial survey for topographic mapping, rather than to the Western Front. The elimination of tilt must on economic grounds be a much more important question for surveys in peace time than is the rectification of distorted photographs. One must note, however, that in any future war in Europe the fight for air supremacy will be long and costly, and in such a war we shall have to consider rectification as a matter of importance, unless improvements in the type and arrangement of camera fittings have succeeded in guaranteeing a vertical position at all times. War conditions are outside the scope of the present paper, but it is interesting to note, in passing, that experiments in photographing the horizon on two planes perpendicular to each other and to the plane of the map photograph were carried out very sketchily in a very old type of aeroplane and far too hastily condemned. I have this fact on the personal authority of Mr. Douglas. Criticisms on such an excellent paper as we have heard are not easy to make; there are, however, one or two points. Captain Hamshaw Thomas quotes Captain Richards as saying that where ground was flat, and triangulated points close together, the detail of small features was more accurate than a plane-table survey could accomplish under military conditions. Even where the ground is hilly, Captain Richards considers that local shape would be better than in an ordinary military plane-table survey. I think that both Captain Richards and Captain Hamshaw Thomas have been a little biassed in their opinions in comparing their results with surveys of a reconnaissance type and not with a good topographical plane-table survey. The 1-inch survey of Palestine was done many years ago with instruments and methods which are now discarded. There is a wide difference between such a map and a carefully executed plane-table survey. It was particularly noticeable in France that one or two sheets lying to the south of Albert, which were surveyed on the plane-table, could not be bettered by revision from photographs, and remained perhaps the most reliable sheets we possessed. Moreover, one need only investigate such plane-table maps as the 1-inch of India and the 2 inches to 1 mile of Jersey to see that good plane-tabling is a serious rival even to the newly developed use of aerial survey. Again, Captain Hamshaw Thomas stated that in six weeks' time an officer compiled an area of 20,000 yards by 28,000 yards. He states that this method probably compares very favourably with other methods of map production as regards rapidity. Now, I am not quite certain what Captain Hamshaw Thomas wishes to imply. The compilation is a stage which has no exact parallel in the process of the production of a map from ground survey. There is nothing to which one can compare it. But this brings one to the most important question of all. It is the question of comparative cost, which is usually much more important than rapidity. In war time, with unlimited funds at one's disposal and time as an all-important factor, there is no question that air photography is an invaluable aid to mapping. In peace time money becomes the all-important factor; the question of time is usually of secondary importance only. In the case of that famous and hard-worked little unit, the Colonial Survey Section, topographical and trigonometrical hands work together; the total staff is only six, and the time taken in extensive surveys is naturally long. On the other hand, the cost is very small, and before the war (though in expensive colonies) the cost of the topography

(as apart from the triangulation) was of the order of 4*s.* a square mile on the 1-inch or ½-inch scales, inclusive of contours.

The chief omission in all literature of air-photo-survey up to the present moment is the lack of any detailed estimate of the cost of a map so produced. This criticism is not offered as hostile. I am convinced personally of the enormous importance of air photography for survey purposes, but progress can hardly be expected for so long as the survey can be conducted as effectively and cheaper by other methods, nor can a start be made until the economic question has been thoroughly thrashed out. This criticism in effect strengthens Captain Hamshaw Thomas's contention that intermediate and probably unnecessary steps should be eliminated, and that it is more important to secure an undistorted photograph than to perfect methods of rectification. Captain Thomas has spoken of the hydrographic possibilities of the method. It is interesting to know that the French are now getting good results on the coasts of the eastern Mediterranean by these means. A very old friend of the British "Field Survey" units on the Western and Italian Fronts, Colonel de Vanssay, is, I believe, engaged on the task.

Mr. A. R. HINKS: Of the many remarks suggested to me by Captain Thomas's most interesting and valuable paper, there is at this comparatively late hour only one that I will venture upon, and that is to express the hope that somewhere in the organization of this co-operation of the future between the Air Force and the Survey Sections and the Artillery there may be established some small department which we might call, for the want of a better name, an experimental laboratory, where it may be possible to collect all these various experimental notions that have been developed on different fronts and in different circumstances, and where somebody shall have the duty of trying to perfect, and simplify, and make really working, the various methods—some of the rectification of photographs, some of the use of the stereoscope—that have been evolved. The enthusiasm of the war may, I hope, be found to survive in the production of such a department as this. It is perhaps the most useful that can be done in the furtherance of this very interesting subject. The very small experience I have personally of the methods of the rectification of air photographs shows that there is a great deal of theory in existence which has not, if one may say so, been efficiently translated into practice. One has not anything like reached the end of the apparatus that really makes it a working method. Then there are the stereoscopic methods. One wants to have available all the best types of apparatus, especially some of the very interesting things devised by the French. And, in general, one wants a little experimental laboratory where one or two men with a taste for optics and mechanics should have at their command a workshop, which need not be elaborate, but where they can fit up apparatus in laboratory style and really work out these methods; where they will allow people interested, but not having the time to carry out these experiments themselves, to come and talk over matters; and where one could have the nucleus of a really progressive organization for the future.

The PRESIDENT: Sir Geoffrey Salmond appealed to me as President of the Society to keep up enthusiasm in the air. Well, our next afternoon meeting is to be about the air, and we hope that we shall have in this session possibly, and certainly in next, a paper at one of our evening meetings on the air route to India. We had our eye upon Sir Geoffrey Salmond for that paper, but he is going to India before he can give it. We also hope to have papers on the air route to the Cape, the air route to Australia, and so on. We do recognize in the Society the very valuable aid which the air can give us, not only in the time

of war, but in time of peace. The lecturer referred to the taking of photographs of the changes of the rivers in India; that is most valuable work to be done. Sir Geoffrey Salmond spoke of the Government of India at the present time having already surveyed the upper part of the Sutlej. We, in this Society, had also our eye upon the Government of India for making use of the air forces out there to have an air reconnaissance of the neighbourhood of Everest. We began talking about that a year ago. We have had some difficulties up to the present, but we hope they may be soon overcome, and that we may be using the air for getting reconnaissance of the country immediately round Everest, of which we know nothing at all at present, to enable the Alpine Club to send men up the highest mountain of the world. So that you see, we do in the Society recognize how very much air photography can assist in geographical enterprise and research. It only remains for me to thank the lecturer on your behalf for his full and interesting lecture, which has aroused so interesting a discussion.

[Colonel Jack sends the following note, which he would have contributed to the discussion had time allowed.—ED. *G.J.*]

Colonel E. M. JACK, D.S.O.: Captain Hamshaw Thomas, in the methods which he has described, aimed at the elimination of errors due to oblique pointing of the camera, rather than to provision of means for rectifying those errors. This was evidently the most direct means of arriving at the object he had in view, and was possible in the conditions which obtained in Palestine. Lieut.-Colonel Winterbotham in his remarks said that Captain Thomas had proved that it was possible to take a long series of air photos vertically; but this statement should be qualified by consideration of the local conditions, as it is not possible to ensure verticality at all times and in all places, as Captain Thomas is himself the first to admit. The matter is of some importance as affecting the question of future experiment. For mapping by air photography we should know, if possible, the direction and amount of tilt for those photographs which have not been taken vertically, and it is admitted that in certain conditions (especially war conditions) there will be many such. This knowledge would be useful in the case of the reconnaissance maps described by Captain Thomas, yet is not necessarily essential; but for anything like accurate mapping it becomes most important. If we have this information we can utilize all photographs easily and quickly; if we have not, the difficulties of rectifying them are greatly increased, and the time required is much longer; and in certain cases they cannot be used at all. Further, with such information, combined with knowledge of the height of the aeroplane, we can use photographs taken out of the vertical for determining heights. It is therefore most important that attention should be directed not merely to securing vertical pointing of the camera, but also to devising some means of recording accurately and automatically the direction and amount of the tilt at the moment of exposure. The provision of some such an arrangement is in my opinion one of the most important objects of research in the future, if not the most important. The provision of a method of fixing at the same moment the height above ground of the aeroplane is also important, but is probably a simpler problem.

THE ISLANDS AND CORAL REEFS OF FIJI

W. M. Davis

Emeritus Professor of Harvard University; Gold Medallist R.G.S. 1919

(*Continued from page* 220.)

Part III. Various Conditions of Coral-Reef Formation.

Fringing Reefs of a New Generation above Drowned Barrier Reefs.—After a barrier reef has been developed during the slow subsidence of an island, preceded by cliff-cutting or not, a more rapid subsidence of very recent date may take place; and since then the corals of the submerged reef, even though not killed, may not yet have had time to grow up to the surface again. Or the recent subsidence may be rapid enough to submerge the reef to a greater depth than that at which its corals can continue to flourish; the reef will then be gradually destroyed by boring organisms and wave action, while its lagoon floor will be more or less aggraded. Thus a comparatively flat submarine platform will be produced around the island, along the well-embayed shoreline of which an unconformable fringing reef of a new generation, facing the open sea, will be in the mean time developing on the non-clift spur ends at a higher level than the drowned barrier reef. As in the case of cliff-rimmed islands, so here again, good examples are not found in Fiji, but they abound elsewhere.

Palawan, the long south-westernmost member of the Philippines, is an admirable illustration of an island of the above-imagined kind, as I have recently shown (*Proc. Nat. Acad. Sci.*, 4, 1918, and *Bull. Geol. Soc. Am.*, 29, 1918, 515). It is bordered, on the west at least, by a broad platform with an imperfect rim which appears to represent a former lagoon floor and a discontinuous barrier reef; and as the depth of the platform varies from 20 or 30 fathoms near the island ends to 60 fathoms at its mid-length, the submergence must be due to an unequal subsidence and not to a rise of ocean level, which would be everywhere of one measure. Parts of the western coast of the island are marvellously embayed, but the spur ends between the bays are not, as in New Caledonia, truncated by cliffs; hence the platform cannot be the work of abrasion. The coast must therefore have been protected from strong waves by an off-shore reef before it was submerged. At the southern end of the island, where the platform is shallowest and where the subsidence must therefore have been least and slowest, the fringing reefs of the new generation are one or two miles wide; but near the middle of the island, where the subsidence was greatest, the headlands are very little fringed with reefs; consequently the last movement of subsidence must there be of

very recent date, like that of the Marquesas. Palawan therefore offers excellent examples of fringing reefs of a new generation above a drowned barrier reef. It is evidently possible that the platforms around the Marquesas islands and Tutuila may, like the platform along Palawan, represent submerged barrier-reef lagoon floors, instead of being simply platforms of abrasion.

Let it be noted here that, although the fringing reefs of Palawan were formed in association with rapid subsidence in a manner that was clearly conceived by Darwin ('Coral Reefs,' 1842, p. 124), he regarded this manner of fringing-reef formation only as a theoretical possibility and found no examples of it. Apart from the fringing reefs that occur in the lagoons of barrier reefs, all the sea-facing fringing reefs of which he had records were interpreted as having been formed on stationary or rising coasts. As a matter of fact, many fringing reefs that face the open sea are found on embayed coasts that appear to have suffered rapid submergence, presumably due chiefly to subsidence; witness not only the fringing reefs of other islands in the Philippines, but also those of the Andamans, the Seychelles, and elsewhere. All such reefs should be regarded as of a new generation, and as indicating a subsidence of so rapid a rate that the pre-existing reefs were unable to neutralize the resulting submergence by upgrowth. Fringing reefs of this kind may therefore be cited as showing that subsidence has by no means always proceeded at no faster rate than that at which corals can build reefs upwards, and as thus refuting the objection against Darwin's theory of subsidence by some of its critics who, in ignorance of these reefs, have supposed that the theory imposed a limit on the rate at which subsidence could take place.

Fringing Reefs around Fauro in the Solomon Group.—In illustration of the contradictory interpretations that may be offered for the reefs of one and the same island, a paragraph may be devoted to Fauro, a small western member of the Solomon group, the fringing reefs of which are as good examples of reefs of a new generation as are those of Palawan. Fauro is described by Guppy in his book on the Solomon archipelago as a deeply denuded mass, "the basal wreck of some huge volcanic cone"; "so great has been the degradation of the surface that we have nothing more than the cores or basal remains of the ancient volcanic cones, which have built up this island" (pp. 3, 40; 1887). Although this painstaking observer mentioned the "deeply indented sea-border" of the island and noted that "narrow shore reefs fringe the coast," he did not recognize that the indented sea-border and the manifestly unconformable contact of the narrow fringing reef with the greatly denuded island rocks testify strongly for rapid subsidence previous to the formation of the fringing reef; nor did he interpret the extensive submarine bank which extends around the island, especially on the north, as a submerged barrier-reef lagoon plain of an earlier generation.

On the contrary, although he had previously accepted Darwin's theory of subsidence, and although he remarked that "it is worthy of note that neither in this . . . island . . . nor in the adjacent smaller islands of volcanic formation did I find any raised coral rock," he here rejected Darwin's theory and concluded that all the reefs of the Solomon islands, those of Fauro with the rest, were formed during "an alternation of long periods of upheaval with lengthened intervals of repose" (p. 127). Not only so: two reviewers of Guppy's book shortly after its publication gave no more heed to the indented shorelines and the unconformable reef contacts than he did himself. One of them complimented him on having "demonstrated that the old theory [of subsidence] fails and the new [Murray's theory of outgrowth] succeeds"; and the other commented upon "the nervous reluctance of many geologists to accept any explanation of the origin of coral reefs unconnected with or adverse to the subsidence theory," and urged that "no matter how great may be the authority of any one individual . . . if a series of facts, such as those recorded in the work before us, are plainly repugnant to the theory of subsidence . . . it is the manifest duty of geologists especially to examine such facts without prejudice and to be ready to modify their views in accordance with the ever-advancing tide of scientific knowledge." One must cordially agree with this homily as to the duty of geologists, but one may at the same time wonder what its writer considered the duty of reviewers to be!

The nearest approach to the Palawan or Fauro type in Fiji is probably to be found in the Yasawa islands on the north-western side of Viti Levu; for some of these islands, surrounded only with fringing reefs, lie exposed to the open sea between the uncompleted ends of the great barrier reefs which stretch northward from the north-west side of Vita Levu and westward from the west end of Vanua Levu, very much as if the intermediate part of the barrier reefs had been drowned. Unfortunately, there are no soundings by which this supposition may be tested.

Rarity of Reefs on Coasts of Emergence.—In supplement to the above discussion of the "three neglected considerations," brief reference may now be made to a fourth line of evidence in favour of reef-upgrowth on submerging foundations, which is afforded by the rarity of reefs on gently sloping coasts of emergence, as exemplified along much of the coast of Borneo, along the southern coast of Java, on the Madras coast of India, and elsewhere; for all these emerged coasts are bordered by slopes of gentle declivity and have non-embayed shores bearing beaches of unconsolidated sediments, on which corals find no suitable opportunity for attachment. When the marine deposits of volcanic detritus ("soapstones," along the southern side of Vita Levu first emerged in the form of a coastal plain, they were probably reefless, like the present coast of Madras; the barrier reef that now rises off the coast appears to have grown up after the mature erosion of the coastal plain to its present hilly

form, and during its submergence to its present lowered level and reduced breadth.

However, certain mountainous members of the Australasian archipelagoes, like Celebes and Halmahera, which are known from geological evidence to have suffered recent upheaval, have fringing reefs along parts of their shores; but in all the examples regarding which I can find sufficient descriptions, these reefs are unconformably attached to relatively bold slopes of resistant and eroded rock structures; hence not long before their recent emergence the islands suffered a still greater submergence. This geological aspect of the problem need not be pursued further here. A matter of more general importance must be next discussed.

Subsiding Islands or Rising Ocean.—In view of the above presentation it may be concluded that the evidence afforded by embayed shorelines, unconformable reef contacts, disposal of detritus, fringing reefs of a new generation on embayed coasts, and the prevailing absence of reefs on coasts of emergence, suffices to exclude all still-stand theories of barrier reefs; and if so it makes still-stand theories of atolls improbable also, for atolls not infrequently occur close to barrier-reef islands in Fiji, as well as in the Caroline and Society groups. At the same time these lines of evidence seem to accredit the theories which explain the formation of barrier reefs and of atolls by upgrowth from submerged foundations. It therefore remains to inquire whether the submergence thus demanded is chiefly due to a rise of ocean level around almost still-standing islands, or chiefly to a subsidence of the islands in an ocean of almost unchanging surface level. Three lines of inquiry are here to be followed: The first inquiry shows that if changes of ocean level take place, they must everywhere be simultaneous and of the same amount; that is, each submergence resulting from such changes must be of the same amount, rate, and date on all insular and continental coasts, unless the coasts also change their level at the same time. The second inquiry shows that if submergence is due to island subsidence it may vary in amount, rate, and date from island to island, and may be synchronous with the emergence of other islands due to upheaval. The third inquiry proves that a submergence of such an amount as 500 feet is much more economically produced by the local subsidence of the coast on which the 500-foot submergence takes place, than by a universal rise of the ocean by that amount.

Diverse Movements in Fiji.—As to the first two of the above inquiries, Fiji shows, as above indicated, abundant examples of both emergences and submergences of unlike amounts, dates and rates. The south-central islands of the group, Nairai, Ngau, Moala, Totoya, and Matuku, give no evidence of emergence but plentiful evidence of submergence, for they have no uplifted limestones, and their coasts are well embayed; and their submergence must be of recent date, for the embayments are but

partly delta-filled and the reefs are narrow. Certain islands show a slight emergence of recent date; for example, Ovalau, on which a corniced shoreline may be traced around the spur ends, about 4 feet above sea-level, as in Fig. 10. Makongai exhibits a similar feature. A number of the east-central islands, Vatu Vará, Mango, Naiau, Kambara, and others, afford evidence of recent emergence of various large amounts up to 1030 feet, for they are composed wholly or in part of elevated reefs which stand at different altitudes and which have suffered little erosion since they emerged.

The farther eastern island, Vanua Mbalavu, mentioned above, bears unconformable elevated coralliferous limestones now much dissected; the dissection of their reef limestones testifies to an earlier emergence than that of Vatu Vará and the other little-eroded limestone islands; and the unconformable contacts of the limestones on the eroded lavas testify to a still earlier submergence. Furthermore, the present shoreline of Vanua Mbalavu is embayed in such a manner as to suggest that a recent submergence, in connection with which the present barrier reef grew up, has taken place after the emergence and dissection of the earlier reef, and apparently at about the same recent date as the emergence of the limestone islands farther west. Moreover, the large lagoon, 20 miles in diameter, enclosed by the extensive barrier reef of the Exploring Isles of which Vanua Mbalavu is one, is only 20 or 25 fathoms deep on its western side, and yet reaches the exceptional depths of 80 and 90 fathoms on its eastern side, as if a tilting had lately occurred, as Agassiz suggested; and such a tilting to the east goes very well with the emergence of the recently emerged limestone islands to the west: yet still farther west a number of islands show no signs of recent emergence. The evidence of diverse movements for Lakemba in eastern Fiji, ending with an eastward tilting, as presented by Foye and briefly stated above, may be here referred to again. This observer finds that, after the central volcanic mass of Lakemba had been maturely dissected, it subsided sufficiently for the unconformable deposition of from 300 to 325 feet of coralliferous limestone; and that the compound mass was then uplifted with tilting to the east, so that while the unconformable limestones are exhibited around the western side of the island, a sea-level barrier reef loops around a lagoon that extends 6 miles to the east (*Proc. Am. Acad.*, 54, 58–60; 1919). Whether these movements deserve to be called "cumbrous" or not, they certainly seem to have taken place.

The occurrence of an elevated reef a little inland from a sea-level fringing reef on the south-western side of Viti Levu, where no off-shore barrier reef occurs, and a similar association of elevated and sea-level reefs on the southern side of Vanua Levu, must be considered in connection with the absence of elevated reefs and the great development of far-offset barrier reefs on the north-western and western sides of the same

islands. This appears to show that local uplifts occurred in the recent past where the elevated reefs occur, and that the uplifts are now followed in the same districts by a still-stand or a very limited submergence, while long-continued submergence characterizes other parts of these large islands; in other words, the region of the two large islands has experienced a long-continued but gentle tilting to the north-west. These islands thus appear to occupy so large an area that they each suffice to show differential movements which are, as a rule, elsewhere discovered only by comparing the features of two or more smaller islands.

In further evidence of a tilting movement of Viti Levu it should be noted that one of the barrier-reef arms which stretches out from the north-western side of the island gradually decreases in breadth as it advances, and that further on it is continued by a submarine reef, which soon becomes interrupted; at the same time the adjoining lagoon floor, 20 fathoms deep near the island, extends beyond the interrupted submarine reef as an almost rimless platform, the depth of which gradually increases to 58 fathoms before it falls off into deep water at a distance of 28 miles from the main island. It is in association with another part of this extensive barrier reef, but beyond its unenclosed ends, that some of the Yasawa islands bear, as above noted, only fringing reefs; this suggests that the recent tilting of Viti Levu increased north-westward to such a measure as there to drown the barrier reef and replace it by a fringing reef of a new generation. But let it be noted that, as on Vanua Mbalavu and Lakemba, the emergence of the elevated reefs on the south coasts of Viti Levu and Vanua Levu appear to have been preceded by a submergence; for the reefs there seem to lie, as well as their structural relations can be inferred from the descriptions by Guppy, Agassiz, and Andrews, unconformably on an eroded volcanic foundation; and this inference is explicitly confirmed by Foye's observations (*Proc. Am. Acad.*, 54, p. 33; 1918).

The foregoing considerations must make it clear that the emergences and submergences of Fiji cannot possibly be explained by uniform changes of sea-level around still-standing islands, nor by the elevation of the group as a whole, in spite of the authoritative statements above quoted to this effect. Whatever changes of ocean level have taken place, nothing but local, successive, and diverse movements of the islands themselves, including uplifts as well as subsidences, varying in amount and date and in some cases clearly involving alternation between subsidence and uplift, can explain the observed facts. Furthermore, barrier-reef growth appears to be associated in all cases with the occurrence of subsidence.

Changes of Ocean Level by Crustal Deformation.—The third inquiry above alluded to, regarding the economy of island subsidence as compared to the extravagance of changes of ocean level, confirms the

conclusions just announced, as I have elsewhere shown (*Am. Journ. Sci.*, 40, 259; 1915). If the recent emergence of Vatu Vará, whereby it gained an altitude of 1030 feet, be explained by a lowering of the ocean level, then all the ocean bed, except the small area on which Vatu Vará stands, and all the continents that did not then emerge, must have sunk 1030 feet; or if all the ocean bed did not sink, then a tenth of the ocean bed must have sunk 10,300 feet, and all the non-emerging continents must have sunk 1030 feet. But these measures, large as they may be, are based on the improbable postulate that no compensatory rise took place in some other part of the Earth's crust at the same time.

If a rough compensatory deformation be assumed, so that when a tenth of the ocean bed sank in one region a similar area rose in another region, then the failure of compensation by which the sinking of one tenth exceeded the rising of the other must have measured 10,300 feet, in order that Vatu Vará should emerge 1030 feet. But this is not all; the submergence which permitted the formation of the now elevated and dissected reef on Vanua Mbalavu measured 700 feet at least, and the emergence by which the reef gained its elevation was of similar measure; and both these movements antedated the recent emergence of Vatu Vará. They also would therefore demand great movements of the ocean floor elsewhere, if the ocean changed and the Fiji islands stood still. Hence the gratuitous supposition that Fiji has stood still demands repeated and extravagant movements of large areas of the ocean bottom elsewhere, instead of the small and local movements of the islands themselves, as assumed under Darwin's theory, in the place and by the amount demanded. In the absence of direct proof of great movements in the ocean bottom, it is reasonable to ascribe most of the changes of level to the islands.

The Glacial-control Theory of Coral Reefs.—Unreasonable as it thus becomes to account for all the various emergences and submergences of the Fiji islands by changes of ocean level, some such changes must nevertheless be accepted in connection with the climatic changes of the Glacial period. The lowering and chilling followed by the rising and warming of the ocean, thus caused, has been most ingeniously linked with the formation of coral reefs, particularly of atolls, by Daly in his Glacial-control theory (*Amer. Journ. Sci.*, 30, 1910, and *Proc. Am. Acad.*, 51, 1915), which is to-day the only serious rival of Darwin's theory. I have therefore examined the postulates and processes of this theory as impartially as possible in several papers, with the result of finding it incompetent to bring about the features of coral reefs to-day observed, especially in the Fiji archipelago. The grounds of this conclusion with respect to Fiji are in brief as follows.

The evidence given above regarding barrier reefs shows that various

Fiji islands have suffered diverse emergences and submergences which must be ascribed to the upheaval and subsidence of the islands themselves, because the emergences and submergences differ in date, place and amount; and the evidence shows also that the reefs have been formed when and where submergence permitted their upgrowth. But changes of ocean level also must have taken place during the Glacial period; and submergence caused by a rising ocean would be just as favourable to reef growth as submergence caused by island subsidence. Emergence and submergence thus caused must, however, have been synchronous and uniform. Hence we must conclude that, whatever the amount of such changes, they were of subordinate value compared to the local and diverse emergences and submergences due to uplifts and subsidences, that the islands have actually suffered. It is therefore to these diverse movements that reef growth and reef emergence must be chiefly due. Consequently, the Fiji islands do not exemplify the long-continued stability that is postulated in the Glacial-control theory for a large part of the Pacific, as an essential condition for the production of atolls.

The same conclusion is reached if the atolls and not the barrier reefs of Fiji are examined. Some of the atolls are at sea-level and in process of formation. Others are elevated above sea-level and in process of dissection. Their altitude varies, hence their uplifts must have been of various amounts. Their dissection is in various stages of advance; hence the uplifts must have been of various dates: and if elevation has taken place in Fiji by various amounts and at various dates, it is hazardous to assume that no subsidences have occurred. Furthermore, according to all the accounts that I can gather (*Proc. Nat. Acad.*, 3, 473; 1917) none of these dissected atolls reveals the truncated floor of volcanic rocks that is regarded as a characteristic structural feature of atolls according to the Glacial-control theory. Moreover, it is to my view of the problem highly significant that nearly all the Fiji atolls lie in the far-eastern part of the group, precisely where the eastward tilting of Vanua Mbalavu and Lakemba would indicate the recent occurrence of subsidence; the relation of the Great Argo and several other atolls to Lakemba is particularly significant in this connection. Again, it is noteworthy that the only known "drowned atolls" in the group lie somewhat further east than the atoll belt, as if recent subsidence had there been so rapid and so great that reef upgrowth could not keep pace with it. More soundings thereabouts are to be desired. It may be added that the diverse uplifts and depressions above described are of such nature and distribution that they would result from a west-moving wave-like deformation; but this geological aspect of the problem need not be further developed here.

More pertinent geographical matter is found in the relation of certain Fiji atolls to the volcanic islands of neighbouring barrier reefs; for while the atolls taken alone give little or no indication of their origin, much light is

reflected upon it from the decipherable history of volcanic islands near by, as I have shown in another article (*Proc. Nat. Acad. Sci.*, 2, 471; 1916). Thus several small atolls near Vanua Mbalavu cannot be reasonably supposed to have escaped the ups and downs of that island, an account of which has already been given. Similarly, the Charybdis atoll, an inscrutable structure when examined alone, may be reasonably interpreted as an upgrowth on a subsided foundation when its position to the north of Viti Levu is noted; for that is the side of the main island which, as above described, appears to have recently suffered a tilting depression. For the same reason, subsidence and upgrowth may be inferred for the long almost-atoll north-east of Vitu Levu, in which a small island, Vatu-i-ra, rises to a height of 100 feet; and for the great reef loop on the south-west of Vanua Levu, within which a similar small island survives. In view of the close association of these atolls and almost-atolls with neighbouring islands which appear to have suffered various changes of level in recent geological times, a long period of stability does not seem at all essential for atoll formation in the Fiji group.

But in justice to the Glacial-control theory we must not forget that it was invented chiefly to explain the atolls of the central Pacific, and that it might still hold good there, even if it did not succeed in accounting for the atolls of Fiji. On the other hand, Great Argo and other typical atolls in Fiji are explicitly included in a list of atolls for which the Glacial-control theory is believed by its author to account (*Proc. Am. Acad.*, 51, 188; 1915); and if the features of these atolls, for which the Glacial-control theory with its still-stand postulate is presented as the best explanation, are found to lie in a district of recent subsidence as the tilting of Vanua Mbalavu and Lakemba indicates, doubt is thereby thrown not only on the belief that such atolls can be best explained by the special conditions and processes of the Glacial-control theory, but also on the conclusion that Darwin's simpler theory is incompetent to explain the atolls of the central Pacific region. This doubt is strengthened on finding that the large atoll of Ongtong-Java north-east of the much disturbed Solomon group, and the extensive Macclesfield Bank in the China Sea west of the much-disturbed Philippine islands, are also instanced as products of the highly specialized Glacial-control processes acting on still-standing islands, and not, as I have elsewhere pointed out (*Bull. Geo. Soc. Am.*, 29, 562; 1919), of the simpler process of island subsidence and reef upgrowth that are involved in Darwin's theory.

Apart from the indirect evidence just given, it is difficult to find means of making a critical choice between Darwin's theory and the Glacial-control theory for the central Pacific region, where atolls prevail, for atolls do not disclose their origin; but some of the reefs of the central region are barriers around high volcanic islands; and these give strong evidence for Darwin's theory, as will be shown in the second following paragraph.

Reef-encircled Islands are not Cliffed.—Another assumption of the Glacial-control theory is that reef-building organisms were killed and that preglacial reefs were cut away by the chilled and lowered waters of the Glacial ocean; the existing reefs are assumed to be of post-glacial growth. But if such were the case, cliffs ought to have been cut on the spur ends of the reef-encircled volcanic islands by the lowered ocean, particularly where the preglacial reefs were close set, as on the east side of Ngau, Fig. 6. Surely such an island would have been attacked by the sea if its close-set preglacial reef had really been cut away, as I have elsewhere shown in some detail (*Am. Journ. Sci.*, 40, 241; 1915; and *Sci. Monthly*, 2, 563; 1916). Yet spur-end cliffs of this kind are prevailingly absent; for let it be remembered that the low spur-end bluffs which now rise from sea-level rock platforms on many spur ends are product of wave work at present sea-level, and not of the lowered Glacial ocean.

Furthermore, the Glacial-control theory explains the embayments of dissected volcanic islands—especially of mid-Pacific islands, like Murea, Raiatea, Tahaa, and Borabora in the Society group and Ponape in the Carolines—as occupying valleys that were eroded below present sea-level while the islands stood still and the ocean was lowered about 35 fathoms, and that were invaded by sea-water when the ocean rose again. If this were true, the rock-bottom depth of the embayments as inferred from the slope of their sides could not be explained; for some of the embayments must have been cut down from 500 to 800 feet below present sea-level. Moreover, great cliffs ought to have been cut by waves on the end of the island spurs while streams were deepening the inter-spur valleys; for the time needed for the deepening of the valleys by their small streams, and still more for the widening of the valleys to their observed dimensions by the slow process of weathering and washing the side slopes, would be abundantly long enough for a great abrasive work on the spurs by strong ocean waves. All the cliff-rimmed volcanic islands outside of the coral seas support this view, for their cliffs are much more maturely developed than their valleys. The general absence of spur-end cliffs on Murea, Ponape, and other mid-Pacific, reef-encircled islands therefore militates strongly against the Glacial-control theory; the exceptional occurrence of spur-end cliffs on Reunion, the Marquesas, Tutuila, Tahiti and New Caledonia must be explained by local and not necessarily synchronous conditions, and not by the universal and synchronous conditions that are postulated under the Glacial-control theory.

Hence, plausible as it seems to be to assume that reef-building organisms were killed and that reefs were therefore cut away by the lowered and chilled Glacial ocean, the assumption is not borne out by the facts. Some of the reef-building organisms probably were killed, but enough others must have survived to maintain the reefs against the waves. It is conceivable that the torrid-ocean Nullipores—calcareous Algæ—which do so much work in binding together other reef builders, may have

been replaced during the Glacial period by equally efficient Nullipores from the temperate oceans. However this question is settled, the lagoon floors enclosed by the Fiji reefs should not be regarded as platforms of marine abrasion, afterwards aggraded and reef-rimmed, as the Glacial-control theory demands, for in that case the spur ends should be cliffed. The variation in the depth of the lagoons and the slant of the lagoon floor around the Exploring Isles and north-west Vitu Levu are also features that cannot be explained by the processes of the Glacial-control theory. Again, reasonable as it is to assume that the level of the ocean varied during the Glacial period, the universal and uniform changes of level that would be thus produced do not suffice to explain the various emergences and submergences that different members of the Fiji group have suffered. It is true that the post-glacial rise of ocean level may very probably have served to increase the submergence produced by contemporary subsidence, and to diminish the emergence produced by contemporary upheaval; but in view of the diverse submergences and emergences recorded by various islands in the Fiji group, changes of ocean level must be regarded as of secondary importance as compared to changes of island level. The reefs of Fiji are therefore better explained by Darwin's theory than by the Glacial-control theory.

Conclusion.—An apparently controversial style is imposed upon an article in which a disputed problem is discussed, unless the author does injustice to others by passing in silence over such of their opinions as he cannot accept. But diversity of opinion does not mean enmity, and discussion does not mean warfare; for we are all engaged in the same search—the search for a true explanation of certain observed facts by certain inferred processes in the unobservable past. Discussion is essential in such a search. The important thing is that the discussion shall be logical and thorough, and such have I here endeavoured to make it.

The origin of coral reefs was thought to be settled in favour of Darwin's theory through the middle of the last century, but toward its close several rival theories were announced and Darwin's theory was abandoned by many who had previously supported it. Through so much of the present century as has elapsed, the old problem has been little considered save by a few investigators, and uncertainty as to its proper solution has prevailed. It is as a contribution to the settlement of this uncertainty that the present article has been prepared.

To those readers who are in an uncertain state of mind regarding the origin of coral reefs and yet who still find some interest in considering the problem, I beg leave to suggest the following method of procedure. First, study out the peculiar consequences as to reefs and reef-encircled islands that must follow from each of the several current theories. Second, consider in particular the evidence provided (*a*) by the embayed shorelines of reef-encircled volcanic islands, (*b*) by the unconformable

contacts of sea-level and of elevated reefs with their foundations, especially in the case of sea-level fringing reefs on embayed coasts, and (*c*) by the disappearance of a great volume of detritus from maturely dissected, reef-encircled islands. Third, note the general absence of spur-end cliffs on volcanic islands in the coral seas, although such cliffs occur abundantly on volcanic islands outside the coral seas; but note also the occurrence of cliffs on certain islands within the coral seas, without reefs on Reunion and the Marquesas, with fringing reefs on Tutuila, and with fringing and barrier reefs on Tahiti and the north-east coast of New Caledonia. Fourth, confront the consequences of the several theories with these various features, and consider which theory is thereby best supported. Fifth, examine the discussion of coral-reef theories in the reports of various investigators and in standard text-books, with a view to discovering how far the above method of procedure is there observed, and how far the conclusions there announced are warranted.

After having followed through this procedure myself deliberately and repeatedly, I find it impossible to agree with those who conclude that Darwin's theory is not applicable to the Fiji Islands. Elevation has unquestionably occurred in different parts of Fiji at different times, but has not been characteristic of the group as a whole. Many of the islands show no signs of elevation, but plain signs of submergence, probably due in large measure to subsidence. Where recent elevation has occurred, the unconformable contacts of the emerged reefs show it to have been preceded by subsidence. The relations of several Fiji atolls to neighbouring reef-encircled volcanic islands give clear evidence of both having suffered subsidence. Hence both the sea-level and the elevated reefs of Fiji appear to have been formed in intimate association with the submergence of their foundations, chiefly the result of subsidence at one time or another. The same is largely true of various other Pacific archipelagoes, although in the Australasian region, where upheavals and subsidences have been numerous and rapid, some unconformable reefs appear to have been formed during pauses in an uplift after a previous greater subsidence; but this does not hold true elsewhere. I am therefore persuaded that, even though subordinately modified by the recognition of Glacial changes of ocean level, Darwin's theory of the upgrowth of coral reefs on intermittently subsiding foundations will in the coming years regain the general acceptance that it enjoyed through the middle of the last century.

THE EARLY HISTORY OF NORTHERN ASIA

Russia, Mongolia, China.— Being some Record of the Relations between them from the beginning of the XVIIth Century to the death of the Tsar Alexei Mikhailovich, A.D. 1602–1676, Rendered mainly in the form of Narratives dictated or written by the Envoys sent by the Russian Tsars or their Voevodas in Siberia to the Kalmuk and Mongol Khans &

Princes; and to the Emperors of China. With Introductions, Historical and Geographical. Also a Series of Maps shewing the progress of Geographical Knowledge in regard to Northern Asia during the XVIth, XVIIth, & early XVIIIth Centuries. The Texts taken more especially from Manuscripts in the Moscow Foreign Office Archives. The Whole by **John F. Baddeley,** Author of 'The Russian Conquest of the Caucasus.' In two Volumes, Folio. London: Macmillan & Co., Limited, St. Martin's Street. 1919. *Price Twelve Guineas net.*

IT is a pleasure to join in expressing the gratitude of students of history as well as of geographers to Mr. Baddeley for his extremely valuable book. It appears at an opportune time. Though it is the fruit of researches conducted with painstaking diligence during a good many years, its publication at this moment derives a special interest from the fact that it is the Great War of 1914–18 that has for the first time brought Siberia into the large sweep of world movements. Forty years ago not one Englishman or Frenchman out of ten thousand had heard of Omsk or Krasnoyarsk or Irkutsk, and few indeed were those who had seen that noblest of all the lakes of the Old World, the magnificent mountain-girt Baikal, or had crossed the Yablonoi range. The historians and geographers of antiquity did not know even of the existence of Siberia. To them the vast unexplored regions to the north-east of the Black Sea and the Caspian were parts of Scythia, into which no Greek or Roman had penetrated more than a short way from the Hellenic cities on the north coast of the Euxine, regions peopled by a medley of wild tribes, and in which all sorts of marvels were located, such as the gold-guarding griffins who, according to Herodotus, waged an unending war against the one-eyed Arimaspians. This darkness lasted down till the Middle Ages. Marco Polo, in the thirteenth century, passed far to the south on his journey from Venice to the court of Kubla Khan at Peking. Even the Russians dwelling on the other side of the Ural Mountains do not seem to have entered Siberia till the sixteenth century, except perhaps in the occasional raids to the eastward which the men of Old Novgorod are said to have made in the days of that city's greatness. Russian conquest began with the adventurer Yermak in the days of Ivan the Terrible. There was little resistance to those who came after him—he was drowned in the Irtish in 1584—and before the middle of the seventeenth century Cossack bands had crossed the country as far as the Pacific. The first mention of the inland route in English literature seems to be that in the continuation of Robinson Crusoe, in which Defoe brings his hero back to civilization from China along a route which must have been nearly parallel to that now followed by the Trans-Siberian railway from Lake Baikal to the Volga at Samara.

A large part of Mr. Baddeley's book is devoted to an almost untrodden field of history, the attempts of Russian princes to open up communications with the potentates who ruled in Mongolia and China; and he gives us illuminating accounts of the diplomatic missions sent out through Northern

Turkestan and across the Mongolian wildernesses to Peking, where the envoys were usually received with that mixture of hauteur and timorous suspicion which the rulers of China were wont to show. The narratives of these missions confirm the impression which the readers of Aurel Stein's travels have formed, that there was far more coming and going between East and the Far East in those days than we have been accustomed to think. Mr. Baddeley has not only given us light on dark corners of Asiatic history and ethnography, for which historians will have much reason to thank him, but has investigated not a few puzzling problems in the annals of early Russia. His book is a contribution of permanent value.

BRYCE.

In these handsome volumes Mr. Baddeley has reproduced a number of important documents relating to the period mentioned on the title-page, chiefly acquired by a search in the archives at Moscow, where he was assisted in his work by Russian professors and heard their latest conclusions on ethnographical and other questions up to the outbreak of the war. Many of the maps and narratives have never been published in English, and have been copied direct from Russian sources, while others are extant only in German, Dutch, or Swedish versions. The collection therefore offers to the English reader a mine of information on matters otherwise far removed from his ken. As preparatory to the main subject, Mr. Baddeley gives useful sketches of Russian and Central Asian history, with chapters on Lamaism, the Kalmuks, the Urga Khutukhtas, and other subjects suggested by the narratives dealt with.

Russian history he traces from the earliest times. We cannot enter here into the vexed ethnographical questions connected with the numerous tribes which occupied Russian territory at different times. We can only mention that since the theory of a Mongolian origin of the Scythians has gained ground, Russians have been less eager to claim a descent from this people, and that the opinion now prevails that the Ural and Altai races should be separated, and not be classed together in one Ural-Altaic group. Passing over the Bohemian, Khorvat, and Bulgarian kingdoms in the east, and the Khazar and Bolgar on the Volga, the coming of Rurik, and the Mongol conquest, we come to the flourishing period of Novgorod, which from the eleventh century sent out expeditions to the Urals and even as far as the Ob River, thus inaugurating the Russian penetration of Asia, and, having suffered little by the Mongol invasion, was able to retain its hold on Yugria until the establishment of the supremacy of Moscow, when Novgorod, in 1478, ceased to be an independent state.

The story of Central Asia begins with the successors of Chenghis Khan, their conquest of China and subsequent expulsion, and the rise of the West Mongol or Kalmuk power after the great victory of the Ming army near Buyir Nor. The Chinese found useful allies in the Kalmuks, and obtained considerable influence in Mongolia. Under Dayan, who

died in 1543, the Eastern Mongols rose again into importance. They often raided the Chinese empire, but at length, unable to conciliate the Kalmuks, were forced to make peace with the Chinese in 1571. The conditions obtaining in Central Asia at the commencement of the sixteenth century are more particularly described in a separate chapter.

After the reduction of Novgorod, expeditions were sent out against Yugria in 1483 and 1499, and the capture of Kazan and Astrakhan in the middle of the sixteenth century gave the whole of the Volga to the Duke of Muscovy. The travels of Herberstein, Jenkinson, and other Englishmen, and the exploits of the Cossack Yermak, fill up the interval to the great Russian expansion in the period especially discussed in Mr. Baddeley's work. The advance was rapid, and long before the end of the century the Tsar had extended his dominion as far as the basin of the Amur and into the Steppes.

It is the geographical introduction and the map reproductions which accompany it which will naturally appeal with greatest force to the readers of this journal, and it cannot be adequately dealt with in a preliminary general notice like the present. A fuller discussion of its contents must be left for a future occasion. In it the author gives the chief attention to the progress of knowledge of Northern and Central Asia as revealed by maps. After noticing two or three Chinese maps, and the principal European examples from Dulcert (1339) to Sanson (1554), he concludes that "practically the whole of the information added to European maps of Middle and Northern Asia from Ptolemy to the second half of the seventeenth century—a period of no less than fifteen hundred years—came from Edrisi, Marco Polo, Wied, Herberstein, Jenkinson, and Massa." From about 1650 onwards precise knowledge begins at last to be displayed. One of the earliest maps reproduced, and the earliest Russian map, was compiled in 1667 at the order of the Tsar by Godunoff, governor of Tobolsk. The original disappeared long ago, but Mr. Baddeley has been able to reproduce three copies, one Russian and two from Swedish sources. In these the area between the Volga and Dvina on the west and the eastern coast of Asia, and from the Arctic Ocean to Tibet, is shown in the form of a quadrilateral, almost square, with the Olenek river at the north-eastern angle, the Lena and the Amur crowded against the eastern coast, and China in the south-eastern corner. An ethnographical map of 1673, bound up in Remezoff's atlas, but not, as Mr. Baddeley shows, of his construction, shows increased knowledge. For instance, Kamchatka and Korea appear as peninsulas, and an unknown extension of the continent to the north-east is indicated. Maps by Remezoff, Renat, Unkovsky, and excerpts from the Jesuit maps are also shown.

The second volume contains translations of Russian accounts of journeys in Siberia and Central Asia, the Russian texts of some of these being printed at the end of vol. I. Many of the envoys to Mongol or Kalmuk chiefs were uneducated men, not able even to read and write, not

gifted with much power of observation, and only eager to carry out their mission faithfully. On their return all the information they had been able to collect and remember was taken down from their lips. Spathary, a learned Moldavian of Greek extraction, is a brilliant exception. These records are introduced by a chapter on "Russia and the Yenesei," in which is incorporated Massa's *Kort Verhael* of Siberian roads, and other extracts. The journey of Petlin and Mundoff (1618–19) is of especial interest, as this was the first Russian mission to China, and, indeed, the first European mission which reached Pekin and returned in safety. Spathary wrote journals of his journey from Tobolsk to the Chinese frontier, and of his further journey to Pekin and his residence there, besides a description of the Amur and a description of China translated for the most part from the Jesuit Martini's 'Atlas of China.' These Mr. Baddeley has translated wholly or in part.

The foregoing *résumé* will convey some notion of the large amount of new information here placed within reach of English readers. Furthermore, Mr. Baddeley, having an extensive acquaintance with the literature bearing on his subject, has bound his material into a connected whole by numerous commentaries and excerpts, and has elucidated difficult points, or at least suggested probable solutions. His work can be fully appreciated and criticized only after long study. No book is entirely free from errors, and one it may be well to mention as being of some importance. Bogatyr is not a personal name, but a title. The word denotes a valiant man, a champion, and secondly a ruler, chieftain or duke. In the Russian text of Savelieff's report, where the envoys are summoned to the quarters of the Kalmuk taisha (p. ccxxi.) occur the words (passed over in the translation) *izb yevo Bogatyrevnykh*, a very singular expression if Bogatyr were a personal name, but which may be rendered "his Ducal Lodge." When Bogatyr occurs alone, the Russians, having no definite article, cannot write *the* Bogatyr, as we should. We can now understand how Kharakula and Bogatyr may mean the same person (p. 31), and why the latter word is prefixed to Talai (p. 37 and n. 4).

An important accessory to a book of this kind is the index. That here provided, which occupies 100 closely printed pages, is extraordinarily full and complete, and must evidently have involved a vast amount of careful labour. Every possible heading is to be found under which information could be desired, and the guidance so given makes the search for such information a matter of ease. This greatly enhances the value of the book as a work of reference, to be appealed to on any of the thousand and one matters on which the author's unrivalled knowledge of his subject is here made available. If any criticism is permissible, it is that too great completeness has been aimed at, some at least of the entries referring to names or words of which only casual mention has been made in the text. But this is a fault on the right side, and the number of such cases may not be great. It could have been wished that all the maps had been

furnished with a title or other means of identification, for though catalogued under numbers, and sometimes referred to by these in the body of the work, the numbers do not, unfortunately, appear on the maps themselves. Owners of the work will no doubt be able to supply them with the aid of the text, and will certainly be well advised to do so. Lastly, there is a valuable bibliography, which embraces all the literature of importance on the subject, whether in Russian or other European languages.

W. A. T.

REVIEWS

EUROPE

Causal Geography of the British Isles.— J. Martin. London: Longmans. 1919. *Maps and Illustrations.* 4*s.* 6*d.*

IT is with a rather unusual and commendable sense of the fitness of things that this text-book of the British Isles opens with a chapter on maps and map-reading, with particular reference to Ordnance maps. It is not otherwise marked by great originality, but it is very well produced, and the maps (except when over-elaborate, and occasionally, it would seem, old) are beautiful. The book offers a few texts for a sermon upon the avoidance of certain non-facts or dangerous statements, which seem to become stereotyped in our school-books. It is high time we should refrain from hailing any longer the Phœnicians as the first of the "great peoples" who "successively held sway" in the eastern Mediterranean. The familiar derivation of Teddington from "Tide-end-town" is a perilous *memoria technica.* Sevenoaks is not a gap town. It (or its nucleus) is 4 good miles from the Darenth gap, on the top of the Ragstone Ridge, and neither the main railway nor the main road through Sevenoaks runs through the gap. A gap may be a good geographical factor, but not when it becomes a pitfall. O. J. R. H.

Shropshire: the Geography of the County.— Prof. W. W. Watts. Shrewsbury: Wilding. 1919. Pp. x., 254. *Maps and Illustrations.* 2*s.* 6*d. net.*

We gather that this book was written for the Cambridge series of County Geographies, but was too long and too fully illustrated to fall into line with the other volumes. It is therefore published independently, though the general style and get-up of that excellent series have been so closely copied as somewhat to obscure the fact. Taken by itself there is no reason to regret the greater fullness of detail: we would not, indeed, have lost any of it. It approaches the perfection of local geographical study, and we need not enlarge upon this assertion, but merely advise any who love Shropshire, or (for that matter) the geography of England at large, to read it. O. J. R. H.

Ireland the Outpost.— Prof. Grenville A. J. Cole. London, etc.: Oxford University Press. 1919. 3*s.* 6*d.*

This little volume, after a long course of text-books and travel-narratives, comes indeed as a literary refreshment. Its basis is geological, as we should expect from the writer, but he reveals also his wide knowledge of the history, anthropology, and literature of the island, and the resulting composition is a true geography. It sets out to prove no new idea: it is "an attempt to regard

Ireland as the outpost of a larger region, from which her people and her civilization have been derived in successive and overlapping waves." But this view of Ireland is well worth insisting upon at the present time, and inasmuch as it is impossible to divorce Ireland, in the mind, from political considerations, it is interesting to observe what geography has to say upon the matter. The writer is wisely restrained and suggestive, rather than dogmatic. Thus we have a comparison between Ireland in the fifth, sixth, and seventh centuries, "undisturbed by the crash of European governments," and Ireland in 1914–19; but the deductions to be drawn are not laid down. Again—"since the twelfth century . . . the Irish have had to settle their external differences with one power only, whose territory, like a huge breakwater, divides them from the continental turmoil from the east. Under the more tolerant outlook of the twentieth century, the same geographical conditions should lead to hereditary friendship, and to the recognition of the outpost as a natural link between the continent of Europe and the great English-speaking commonwealths beyond the western sea." It is not discussed upon which side the balance of tolerance lies. "For the geographer, the tragedy of Munster illustrates the spread of continental influences through the open gate of Dublin; but only the coldness of philosophy will be content to leave the matter there." And at last, "let us come back to our geography, for the gist of the matter was determined by the latest movements of the European platform, and is set down clearly on the map. The gate of Ireland is at Dublin, and the gate stands open to the dawn. Westward stretch the gulfs of the Atlantic; eastward lie the friendly and the narrow seas." It can only be added that the whole essay is instinct with that affection for Ireland the land which is shared by very many who are neither Irishmen nor politicians, and are ready to extend the same sentiment to Irish people, so far as they know anything of them outside the unhappy political connection. This essay should be read on both sides of the Irish Sea.

O. J. R. H.

ASIA

Through Deserts and Oases of Central Asia.— Miss Ella Sykes, F.R.G.S., and Brigadier-General Sir Percy Sykes, K.C.I.E, C.B., C.M.G. London: Macmillan & Co. 1920.

This charming book deserves a place in every traveller's library, for as a travel story it is in some respects unique. Other ladies than Miss Sykes may have written about Central Asia (there cannot be many of them), but it is quite unlikely that they have written from the vantage-point conferred by such a position as that of the British Consulate at Kashgar, wherein all the varied types of humanity of a most remote region would present themselves in due course. Such an advantage, combined with all the essential qualifications of a good travel-story teller—the power of intelligent and close observation, a good memory, and a charming simplicity of literary style—make the book exceptional as an illustration of the life, manners and ideals (if they have any) of a people who have remained practically unchanged and uninfluenced by the echoes of happenings in the outside world, and who live essentially the same lives now that they lived more centuries ago than we can tell. Indeed, it is only inaccessible regions such as these that still afford the opportunity for the study of past phases of humanity, and it is delightful on the Asiatic uplands amongst the Kirghiz tent-dwellers and the Sarb agriculturists, to feel the influence of an old world patriarchal atmosphere, so that one might be passing the time of day (so to speak) with Abraham, Isaac and Jacob. Miss Sykes' point of view is essentially feminine—as it should be. There is a good deal in her interesting story about

clothes, and every one who knows and appreciates the vivid and variegated outlook of Central Asian life either in the cities or the plains, will admit that it is the dress of the people that plays the most vivid part in the impressions produced at the time and held thereafter by the memory. There is no change of fashion. There never has been any. The wonderful combinations of colour and the easy fit of the decorative garments is as it was in the days of the patriarchs; the fashion of hair-dressing and the use of the yak's tail to eke out a not too abundant crop is obviously indigenous, and as old as woman's vanity. Miss Sykes is at heart a colourist. Her impressions are full of colour. The beauty of landscape, whether it is the snowline of the Celestial hills, the charm of transient morning and evening effects, or the blaze of scarlet, purple and gold which occasionally pervades the loess plains and relieves the monotony of the usual khaki-clad wilderness, finds its echo in her deep admiration of the delicate traceries and embroideries of the ladies' garments and her love of the charming Kirghiz boys and girls. She does not, however, account for the activity of the women, hampered as they all are, not by tight skirts, but by long boots with heels. To see a Kirghiz girl racing round to collect the camels and sheep for the preliminary "round up" before the morning's march is an exhibition of activity that is difficult to understand.

Not the least interesting chapters in Part I. of this book are devoted to the journey outwards through Russia at a time when Russia was still active in the field of war. Travelling was a rough experience then, and it became rougher as Russian Asia was approached. There are a few lady travellers (of whom Miss Sykes is one and Miss Gertrude Bell another) who appear to be unaffected by the minor disagreeables of such a journey, and who are not given to a failure of nerves under any circumstances whatever. For instance, it must have required exceptional nerve to sleep again soundly after a violent upheaval in bed from below during a night spent in a wretched frontier rest-house, without a preliminary inquiry as to its cause.

Part II. of the book contains new historical information about Chinese Turkestan by Sir Percy Sykes, who has already made his name famous as an historian of the East. He adds a good deal to what was known already of the geographical characteristics of the country, and this contribution, like his other works, becomes a most useful library reference. But we are looking for something more than this from Sir Percy. We want some account of his amazing experiences whilst he was Warden of South-West Persia during the late years of the war. Nothing that he has told us hitherto can exceed the interest of *that* story, if he can only be persuaded to give it to us. T. H. H.

AMERICA

In the Wilds of South America.— **Leo E. Miller**, of the American Museum of Natural History. London: T. Fisher Unwin. 1919. Pp. xxiv. and 428. *With 70 Illustrations and a Map.* 21*s. net.*

In his six years of wandering in South America in search of zoological specimens, mainly birds and mammals, the author has visited in turn Colombia, Venezuela, and British Guiana, has accompanied Colonel Roosevelt to the western highlands of Brazil, and subsequently made a slow and devious progress through Peru, Bolivia, and the Eastern Argentine. At a number of points his travels have led him to localities familiar to the reviewer, who can testify to the fidelity with which they are described. Mr. Miller is evidently a keen naturalist, and many of the facts for which he vouches are of the greatest interest. He has noticed on various occasions, he tells us, that the females of

the howling monkeys desert from the troop when their babies are males, and do not rejoin it until the young are half grown, presumably from fear that the old males would kill them; and he quotes a statement by C. W. Beebe that the older monkeys send their small young to the tip of the slender branches, that they themselves could not venture upon on account of their weight, to pick fruits and then rob them. He describes the accumulations of fish in the muddy pools of a drying morass in the valley of the Upper Paraguay, reproducing some scenes that must have occurred in Middle and Upper Old Red Sandstone times, and have given rise to the accumulations of fish remains sometimes found in the rocks of those formations. His remarkable account of the assault of ants on a hairy caterpillar (p. 235) is unfortunately too long to be reproduced here.

The reviewer agrees with all the author has to say on the amenities of Urucuru, but cannot agree that the way thither from Corumbá is all but impassable, unless it has become much worse in recent years.

It is interesting to find that the rapids on the Rio Gy-parana are caused by a continuation of the same granite ridges as gave rise to those on the Rio Madeira. We are told that the plateau between La Paz and Oruro "is strewn with marine fossils, mostly trilobites, reminders of the days when Lake Titicaca was many times its present size." These may be similar to the trilobites I have found loose in the Apolo Bambo valley. They appear to have weathered out from a calcareous sandstone of Devonian age, and are relics of an open sea that existed long before Lake Titicaca had its first beginnings, or the rocks that form its shores had themselves been laid down.

The description of the irreconcilable Sirionós near Todos Santos is very similar to the accounts of the Guarayas who are said to be found to the west of the Upper Beni, which must not be confounded with the Guarayos further to the south, who are a much milder race.

The illustrations are excellent, but the map is most unsatisfactory. Not only is the scale too small, but the red lines that are supposed to show the author's route are in many places quite incorrectly traced. Tapiropoan referred to in the text is omitted, but another place of the same name is shown several hundreds of miles away. J. W. E.

AUSTRALIA AND PACIFIC ISLANDS

The Quest and Occupation of Tahiti by Emissaries of Spain during the Years 1772–1776. Compiled with Notes and an Introduction by **B. Glanvill Corney, I.S.O.** Vol. 3. London: Hakluyt Society. 1919. *Map and Plates.*

The third volume of the 'Quest and Occupation of Tahiti' brings to an end a series of remarkable interest. The Spanish voyage of discovery of 1772, which took place between the two visits of Captain Cook, was the last attempt of the Spaniards to push out their Empire into the South Seas. During the first trip to Tahiti the Spanish frigate *Aquila* brought back some natives to be instructed in the Catholic Faith; in the second voyage the survivors were returned to the island and Franciscan Friars were left there to convert the natives to Christianity. With them went as interpreter a youth, Maximo Rodriguez, a private of Marines, who had learnt some Tahitian from the youths who were brought to Peru, and had a remarkable aptitude for the native language. His diary, which was lost, was accidentally discovered by Dr. Corney in the library of the Royal Geographical Society, to which it had been presented by Admiral Fitzroy, a companion of Charles Darwin in his famous voyage in the *Beagle*. The diary refers to a treatise on the native

customs as Maximo saw them, but, most unfortunately, this appendix has never been found. What we have is a daily record of his experiences, written apparently by stealth (for the Padres were jealous, suspicious and dyspeptic) in ink compounded out of native dye, and in time snatched from the arduous duty of keeping the natives friendly. But for Maximo the Padres would almost certainly have been murdered, for they made no converts, and their demeanour towards the natives was such that one wonders that reprisals were not taken; but Maximo possessed that rare quality for which we have no word except "insight," which took him straight into the native heart and made this first of the beach-combers a successful observer. Captain Cook seems to have gleaned from the natives information to the effect that Maximo had been carrying on anti-British propaganda. This does not appear to have been true, though if Maximo, a devout Catholic, had said something derogatory of English heretics he would have been doing no more than his duty. One is glad to know that the proverbial ingratitude of the Spanish Government towards its servants was relieved at last by the grant of a commission to this private of Marines, and also that the delay in granting this recompense impelled Maximo to write a memorial setting out his deserts. He married and had children, and it is due to his daughter that the only known copy of his manuscript came into the hands of Admiral Fitzroy.

The book is edited with all the meticulous accuracy and erudition in native custom to which the Editor has accustomed us. BASIL THOMSON.

POLAR REGIONS

The Dutch Discovery and Mapping of Spitsbergen (1596-1829).— Edited by order of the Netherland Ministry of Foreign Affairs by **Dr. F. C. Wieder.** Published by the Netherland Ministry of Foreign Affairs and the Royal Dutch Geographical Society. Amsterdam: 1919.

The author has devoted much time and labour to vindicate the claims of his countrymen to be the discoverers of the whole Spitsbergen group, and has searched out and examined more than two hundred maps, many of which are reproduced in this volume. That the Dutch took by far the most prominent part in this investigation has been fully acknowledged, in particular by Sir Clements Markham and Sir Martin Conway, and it is not disputed that from the time of Purchas to that of Scoresby maps of Spitsbergen were of Dutch type. But Dr. Wieder's bold assertion that "even before 1614 the entire circumference of Spitsbergen was known to the Dutch, except the vicinity of Heley Sound and the east coast of North-East Land and Edge Island" challenges criticism.

The words "a tour d'iceluy pays" in Rijp's report of his voyage after leaving Barents lead Dr. Wieder to believe that Rijp circumnavigated Spitsbergen. The phrase in full, however, is "deposant son cours en amont a tour d'iceluy pays," and there is no hint that he returned to the west coast from the north. Next comes the alleged discovery of Hope Island, here identified with Visch-Eylandt, of which the first mention is made in the instructions handed to May in 1611. It is said to have been visited by Rijp, but it is remarkable that no reference to the discovery is made in Rijp's report or in the fuller narrative of Theunisz. Claesz. Still more mysterious is 't Verlaten Eylandt, also supposed to be Hope Island. In 1611 Cornelisz May is said to have sailed 10 Dutch miles to the west of it, "also (therefore) out of sight," on a course from a point presumed to be Candinos (Kanin Noss) to a point presumed to be Langenes (Sukhoi Noss).

Two remarkable documents are the Plancius globe of 1612 and Joris Carolus' map of 1614. With regard to the former Plancius' own statement that in 1594 he inserted islands in the Arctic Ocean, though he did not believe in their existence, should cause hesitation in accepting its evidence. The coast marked between Spitsbergen and Novaya Zemlya is probably the old Matsyn. The 7 broeders marked on the north-west is the most striking feature, suggesting, of course, the Seven Islands, but by itself hardly warrants the assumption that the north coast of North-East Land had been reached. The map of Joris Carolus has been discussed by Mr. Heawood (*G.J.*, 28, p. 189). Dr. Wieder maintains that Grote Bay on this map is Hinlopen Strait, but longitudes were very uncertain in those days, and therefore the position cannot be depended on ; at any rate, it is drawn as a bay with a well-defined coastline up to the head. It should be noted that Carolus in his atlas of 1634 omitted all his discoveries and copied Bleau's map of 1623.

For the rest Dr. Wieder is on surer ground and shows how the map of Spitsbergen was gradually developed—though, needless to say, he has not been able to clear up all difficulties—and he has illustrated his investigations with a useful collection of reproductions of maps not easily accessible.

W. A. T.

GENERAL

Mountain Memories: A Pilgrimage of Romance. Sir Martin Conway. London : Cassell & Co. 1920. 21*s. net.*

Sir Martin Conway has been somewhere described as "a rolling stone that gathers moss." In the present volume he sheds a further portion of the accretions of his extensive career. Leslie Stephen once wrote 'The Regrets of a Mountaineer,' Sir Martin Conway gives us what may be called the Raptures of a Mountaineer. Climbers as a rule are proverbially reticent as to their feelings, if not as to their doings. Sir Martin Conway is an exception : he both began and left off climbing relatively early in life, and he is now able to look back on his chief adventures through a perspective in which they range themselves in their romantic aspect and just proportions. He writes not so much to furnish useful facts to his fellows as to recall past sensations and impressions for his own pleasure and that of the sympathetic reader. He should find many ; for he has seen much and seen well, and has communed with the Spirit of the Summits in many lands.

Mountaineering literature is apt to be too technical for the general reader. After it lost its first careless rapture its records contracted some of the demerits of the Guidebook and the Sporting Magazine. Minute details of orography and exact records of hours and minutes have their value, but rather in the knapsack than on the bookshelf. Sir Martin Conway has in his time done his duty to the Alpine Club in the matter of Climbers' Guides, and to geographers by the provisions of solid works of travel among the mountains of three continents, and last but not least, Spitsbergen. He has "run afoot over the frozen ridges of the Alps" from end to end ; Andes and Himalaya have each in turn felt the stroke of his ice-axe. But there is yet another way of proving Alpine love —that of learning the infinite variety of the mountains by visiting them at all seasons. Midsummer peak-hunters and votaries of winter sports equally miss the revel of an Alpine spring, the peach blossom seen against the lingering snows in the lake-orchards and the riot of the flowers on the lower fields and pastures. They know nothing of the days when the first frosts spread a carpet of red and gold over the Riffel Alp, and the great peaks, freshly armoured in snow, shine with a new radiance in the low lights of late autumn.

Sir Martin Conway has, he tells us, set down his impressions mainly to please himself and in the spirit of an autobiographer. Their value to others is that he combines a talent for recognizing the distinctive features and moods of mountain landscape with a lively pen and a very varied experience. His present volume should help many armchair readers to understand the joys and toils of the climber, and to form some idea of the strange and sublime scenes which surround him, and of the emotions which they arouse. Before they lay it down they will have had brought before their eyes not only the familiar Alps, but the giant cliffs of Nanga Parbat, the weird icy corridor of the Hispar-Biafo glaciers, the desolate heights of the Andes, and the misty glaciers of Patagonia or Spitsbergen, where the explorer who can prevail over the fogs and slush of the coast region may hope to emerge on the heights into a fairyland of light and atmospheric colour to which the mist-roof of the underworld he has left behind him serves as a silver carpet.

We note a singular accident that has happened among the illustrations. A photograph of the Cima Tosa in the Trentino (never alluded to in the text) is inserted opposite a description of the Falls of the Tosa below the Gries Pass near Domo d'Ossola. We may also note that the Wildspitze, and not the Weisskugel, as here stated, is the highest peak of the Œtzthaler Ferner. The book might well be reprinted as a pocket volume. Its bulk to some extent defeats its purpose, that of serving as a pleasant companion. D. W. F.

Pan-Islam. G. Wyman Bury. London: Macmillan & Co. 1919. 6*s. net.*

This little book is not well served by a title, which may deter those not particularly interested in the history and operation of the Hamidian policy, usually connoted by "Pan-Islam." As a matter of fact, however, this matter is hardly dealt with except in the first chapter, and there but sketchily. The rest of the book is made up of personal observations and reflections, the harvest of a very various and adventurous experience, not only during the War, when the author held a R.N.V.R. commission and served on the Canal and in the Red Sea, but during many years before in Morocco, in the Aden Protectorate, in Yemen, not to speak of India, Egypt and such accessible parts of the "Dar el-Islam." Very few Englishmen have "stepped down into the brown crowd" as whole-heartedly and sympathetically as Mr. Bury. The heterogeneous inconsequence of his book makes it all the easier to read; for one can open it anywhere and find some pithy pointed remark, sufficient by itself and arresting both by its truth and by its originality. Whatever the author has to say, he says as he might talk and not as the scribes; and his new-minted phrases are worth a deal of literary convention. He is at his best describing individuals and groups, their social life, their manners and their customs—Asiris with long spears and short tempers, or Somalis trekking with their booths packed on camels like untidy bird's nests—and he introduces such descriptions anywhere and everywhere with refreshing irrelevance. After a few delightful pages he may remember that he is supposed to be writing a chapter on Missionaries; but he is easily quit of that obligation with a convincing comment, that Asir or the Mullah's country or Hadramaut or whatever land has been engaging his vagrant pen is "not suited to missionary enterprise." Altogether an attractive little book, which disarms criticism. Its author sees as an Occidental into the heart of the Oriental, and as an Oriental into the heart of the West. His criticisms from the two points of view are equally interesting and pungent, and we recommend to all it may concern the Arab conception of the Western missionary as the bagman of a chaotic firm which does not stock the goods it tries to push! D. G. H.

Telegraphy, Aeronautics and War.— **Sir Charles Bright, F.R S.E.** London: Constable. 1918. 16*s*.

At the moment of reading this book some of its interest has passed: the long introduction and the final chapter contain much that bears not at all upon the subjects announced in the title—we chance, for example, on an objection to the extravagance of keeping Pekinese dogs—and show evidence of being written under the stress of war, dealing as they do with such matters as temporary shortcomings of administrators and defects (whether temporary or otherwise) in the character of the enemy. Apart from this, a number of addresses, papers, and memoranda are gathered together here upon the topics which the writer has made his own—inter-imperial telegraphy, cable working, the relative value of cable telegraphy and wireless, and the like. As to the last, the author, broadly speaking, favours the cable, which no doubt justifies the omission of wireless stations from a map entitled "The World's Telegraphic System," though this omission may surprise the general reader. A second section of the book deals with aeroplanes and aircraft engines, and with air administration. In such a collection of papers a measure of repetition is unavoidable, and the book, fairly indexed, is one rather convenient for reference than consecutively readable.

THE MONTHLY RECORD

THE SOCIETY

Medals and Awards, 1920.

His Majesty the King has approved the award of the Royal Medals as follows:

The Founder's Medal to Mr. H. St. John B. Philby, C.I.E., for his two journeys in South-Central Arabia, 1917 and 1918.

The Patron's Medal to Prof. Jovan Cvijić, Rector of the University of Belgrade, for distinguished studies of the geography of the Balkan Peninsula.

The Council has awarded The Victoria Medal to Lieut.-Colonel H. S. L. Winterbotham, C.M.G., D.S.O., R.E., for his exceptional services to the country in the initiation and development of scientific methods of artillery survey, and the production of high-class maps of inaccessible areas.

The Murchison Grant to Miss Czaplicka, for her ethnographical and geographical work in Northern Siberia.

The Cuthbert Peek Grant to Mr. A. W. Pearson Chinnery, to assist him in continuing his work in the unexplored parts of New Guinea.

The Back Grant to Mr. J. M. Wordie, for his scientific work on the Antarctic Expedition of 1914–1917.

The Gill Memorial to Reginald Farrer, for his journeys on the Chinese borders of Tibet.

EUROPE

A Lady's Crossing of the Central Desert of Iceland.

MRS. H. W. Bannon sends us the following account of a journey made by her some years ago across the central desert of Iceland: "It was early in August 1903, my third summer in Iceland, that I decided to attempt crossing

the Sprengisandr from the south end, because it offered a shorter cut to a northern port than the route already traversed the year before; and also, having read Mr. Lock's description of Askja, in the hope of visiting the central volcano, to which the local guide had conducted his own daughter. However, winter threatening to set in early, I had to be content with a distant view of the great 'Basket' standing up, white, against a dark background of clouds. It was in the mysterious crater-lake of this mountain that the German explorer, Prof. von Knebel, and his companion the artist Rudloff met with an unexplained disaster in 1907.* Our start was made at noon from a brook which divides the Sprengisandr proper from the desert lands below; and here some wild swans floated past to a lake lower down. These, with the mountain fox, traces of which were noticed in the fleece of a sheep he had devoured, represent the fauna in this region. As we proceeded at a good pace, the Arnarfall range extending on our left, I was struck by the collections of huge boulders lying loosely like erratics on the surface; but closer inspection revealed them to be of the same volcanic origin as the hills on either side from which they must have rolled. The desert, which averages 3000 feet above sea-level, was sometimes undulating, and at others a vast tableland stretching away in the distance. The tops of the basalt columns resembled a roughly tesselated pavement, over which the ponies' hoofs made a clattering sound; dried-up herbage marking the seams in places, with a few belated florets of the cushion pink—*Silene acaulis*. The weird aspect of these solitudes is very impressive, especially to the imaginative islanders, who people them with mythical beings, mostly harmful to mortals; and a literary Icelander, Grimur Thomsen, was inspired to write a poem—'Sprengisandr'—which has now become a folksong, and familiar in every homestead, though only dating from 1886. Of the sandstorms and columns of whirling sand reckoned among the dangers here I had no experience; having been assured, before starting, that the pass was in excellent condition. Quicksands, always associated with water, there were none, two small lakes at the base of the hill Fordungsalda being all the water in evidence, and these lay off the route. Mist is the thing most feared; but although the hills were sometimes obscured, the guide never lost his sense of direction, though he enjoined the members of the party to keep close together. Just a year before this cairns were put up at intervals along the way, at the instance of the Danish traveller Captain Daniel Bruun, to serve as guides to shepherds searching the desert for strayed sheep. The Sprengisandr terminates at the Egilsá ravine, where the party arrived in the evening at ten minutes past eight o'clock."

Use of the Name "Italia" in the Middle Ages.

Few geographical names have suffered such vicissitudes as that of *Italia*. Originally bestowed on the most southerly part of Calabria (the "toe" of the peninsula), its use gradually spread north so as eventually, in classical times, to cover the whole of Italy as now understood, including even Cis-Alpine Gaul and Liguria, which had for a time remained distinct. But in the third century A.D. the Emperor Diocletian introduced a division of the peninsula between a *Vicarius Italiæ*, whose jurisdiction embraced northern Italy, and a *Vicarius Urbis Romæ*, responsible for all the rest; so that the name disappeared from the very part of the peninsula in which it originated. Henceforth, by a dual use, the name was applied on the one hand to the peninsula in a geographical sense, and on the other to an administrative subdivision. Some writers have seemed to consider the geographical use to be the one generally current throughout

* See *Journal*, vol. 30, p. 436; 32, p. 528.

the Middle Ages, but this was far from being the case, as is shown by an elaborate study of the question by Prof. P. de Grazia in the *Bolletino* of the Italian Geographical Society, vol. 8, Nos. 5-6, 1919. This writer brings together evidence from all available literary sources to illustrate the extraordinary variations in the use of the name from the sixth to the twelfth century. It is a tangled story into the details of which it is impossible to enter here, but the main facts can be gathered from the conclusions set down at the end of the paper. The barbarian inroads to some extent restored for a time the political unity, but the Goths remained too short a time in power to be able to impose their own name on the peninsula, which became once more known as "Italy" in virtue of historical tradition coupled with a vague national sentiment. The Lombard dominion was more enduring, and the name *Longobardia*, originally restricted to the north, largely supplanted that of Italy as the general designation in the mouths of other Europeans, and to the entire exclusion of the old name among the Arabs and Persians. "Italy" became once more used in a restricted sense, and we find two or even more "Italys" existing side by side and taking little cognizance of each other. The name had little currency in the north, which spoke rather of "Campania," "Apulia," or "Calabria"; even Rome was regarded as a special entity outside Italy. Sometimes two Italys were vaguely spoken of—a northern and a southern, corresponding to a *Longobardia major* and *minor*, and known also as *citerior* and *ulterior*. There was also a *Ducatus Italiæ* outside the territory *Totius Italiæ* (the northern part of the peninsula); a *Catapanus Italiæ* (the Byzantine territory); a *Marca Italiæ* (the sub-alpine zone); whilst in the title of King Roger—*Rex Italiæ*—the name referred to the south only. *Italia* means now the kingdom of Italy, now the northern part, now Apulia or the southern region in general, although at the same time the old classical and literary use of the name was never entirely lost. It was kept alive by the learned and the poets, and with the formation of a *lingua italica* in the tenth century once more became current as a comprehensive geographical concept, eventually to come into its own as the designation of a unified nation.

AFRICA

A Genoese in the Sahara in the Fifteenth Century.

M. C. de la Roncière has done good service to students of historical geography by calling attention in the *Bulletin de la Section de Géographie* for 1918 (issued in 1919) to the remarkable visit of a Genoese traveller—Antonio Malfante—to the oasis of Tuat in 1447, and the surprisingly correct information there collected by him on the States of the Western Sudan, and the commercial intercourse maintained with them in those days across the Sahara. The source of information on the subject is a letter written at Tuat by Malfante to Giovanni Marioni of Genoa, which is preserved in a manuscript volume with miscellaneous contents in the National Library at Paris, and of which M. de la Roncière prints the text in full. We have, of course, possessed much of the same information in the writings of the Arab historians and geographers, but the existence of such an account put together by a Christian traveller as the result of personal inquiries in the Sahara itself has hitherto escaped notice. Landing at Honein, the old port of Tlemcen, destroyed in 1534 by order of Charles V., and proceeding south (no doubt by Sijilmessa) in company with an Arab caravan, Malfante crossed the desert to Tamentit, the most easterly of the *ksur* which together form the district of Tuat. Here he was well received, and was permitted to move about freely, his visit arousing great interest among

the inhabitants as giving them the first sight of a Christian, which revealed the surprising fact that his countenance resembled their own. Apart from the fact that his letter—written in Latin—is dated *a Tueto*, his description of the place leaves no doubt of its identity, and he thus anticipated Rohlfs—supposed to have been the first European visitor to the oasis—by over four hundred years. In 1447 the Jews still possessed great influence in this part of Africa, as is described by Malfante, who also gives a correct description of the Tuareg (under the name of "Philistines" by which they were currently known to the Jews of North Africa) and of their custom of covering their mouths, the reason for which he sought in vain. He dwells on the importance of Tuat as the centre of trade between all the Moslem countries surrounding the desert to the north and south, and mentions the principal commodities passing through it; the amount of copper carried south by this route to the Negro kingdoms of the Sudan rousing his especial interest. Although Tuat seems to have been the limit of his actual journey, he was able to collect precise information on the region of the Niger and Central Sudan, as his host at Tuat was a member of an influential merchant family (such as were the ancestors of the historian Al-Makkari), who had lived for fourteen years in the south. He speaks of Teghazza (*Thegida*) with its houses built of rock-salt, thanks to the rainless climate; of the Mandingo State of Meli, whose ruler Mussa the First figured in European maps of the period as *Musameli;* of Timbuktu (*Tambet*); of the Songhai capital Kukiya (*Cuchia*), though he is silent about the other important Songhai town of Gao; of Dendi further south, and of Sokoto (*Sagoto*), as well as of other places whose identification is less certain. He mentions also the great river flowing near Timbuktu (the Niger), and its annual inundations, but thinks like most of his contemporaries that it eventually reaches Egypt, after descending by a great cataract. He also has something to say of the thickly populated Negro countries further south, of the vegetable butter (the *Karite*) there produced, of the fetishes (*idoli*) worshipped by the individual tribes, and of their many different languages. M. de la Roncière illustrates his description by quotations from the Arab and other contemporary writers, and concludes his introduction by pointing out the accurate knowledge displayed in respect of this part of Africa by the famous Catalan map of 1375, which, with Hamy, he attributes to "Cresques lo Juheu," or Cresque the Jew, who would be in a specially favourable position for gaining knowledge of the interior of North Africa from his co-religionists at Sijilmessa and Tuat. It was no doubt the persecution and consequent exodus of many of the Jews of Spain not long after that cut off this source of knowledge from the geographers of Europe. M. de la Roncière suggests that the surprising knowledge of the interior of North Africa shown by Malfante's contemporary Cadamosto (though he hardly left the coast) may have been derived from the Genoese, a compatriot of whom, Antonio Usodimare, was Cadamosto's companion on the voyage.

POLAR REGIONS

Norwegian Occupation of Jan Mayen.

We are informed by the Foreign Office that the Norwegian Minister in London has notified the Secretary of State for Foreign Affairs that the island of Jan Mayen has been occupied by a Norwegian subject. His Majesty's Government have made no protest against this occupation.

GENERAL

Standard Time in Siam.

We are informed by the Siamese Legation that from April 1 Siam has adopted Standard Time of seven hours fast on Greenwich.

An Early Italian World-Map.

Mr. R. L. Atkinson, of the Public Record Office, sends us the following note:—

Among the "State Papers Miscellaneous" in the Public Record Office is an early seventeenth-century Italian map which appears to have been overlooked by bibliographers. It has many points in common with the maps of Mercator and Ortelius, but does not seem to be an exact copy of either. It appears to have been a double-page map in a large folio volume, and is divided into two parts, celestial and terrestrial; the former measures 20″ × 5½″ and the latter 20″ × 9″, while the dimensions of the whole sheet are 23″ × 17½″. The only indications of authorship and date are a small note in the bottom margin, "Fatto in casa del Signior Francesco Robacioli," and two diagrams of the Epact and Golden Number, which begin with the year 1603. Were it a British map this year might have been chosen as the beginning of the reign of James I.; but since it is Italian, it seems clear that 1603 must be the date of publication; otherwise it would have been more natural to choose the beginning of the new century.

The celestial map consists of a series of arcs, representing the heavenly circles of the angels and archangels. At the bottom is a complete circle, superimposed on an outline of the world and marked "Seno di Abramo" (Abraham's bosom). Within this are three smaller circles, marked "Limbo," "Pergatorio," and "Inferno." This representation has marked differences from the Dantesque tradition: there is very little difference between Purgatorio and Inferno, while Limbo is shown as outside both.

The terrestrial map is rectangular, and extends south only just beyond the "circolo antartico." Scales of latitude and longitude are shown, crossing in the centre of the map. This follows the main outlines of Ortelius pretty closely: the chief differences are in the shape of Japan and New Guinea, the north-east coast of South America (much straighter than in Mercator or Ortelius), and the African lakes. These are somewhat nearer their actual relative positions; but this is probably only a more fortunate guess than usual. The nomenclature, too, and various details of the geography, are to some extent independent both of Ortelius and of Mercator, though perhaps somewhat nearer the latter than the former.

The ornamentation is singularly vivid and imaginative. As usual, the Great Southern Continent (shown as including Tierra del Fuego and extending all along the southern part of the map) is full of monsters, fabulous and otherwise, while the seas are infested with ferocious leviathans. The most interesting and curious feature in the ornamentation is a shipwreck (in the bay of the southern continent south of the Indian Ocean) where the sailors are seen escaping in boats while the wreck is attacked by enormous land-crabs (drawn more like lobsters). Mr. Heawood suggests that this may refer to the wreck of a Portuguese ship, the *St. Peter*, whose survivors are said to have been attacked by gigantic crabs; though the scene is shifted far to the south of its true position, lat. 6° S. The incident is described by Linschoten ('Voyages,' ch. 48; Hakluyt Soc. edn., vol. 2, p. 16), who says that it was "paynted in divers places in Goa

for a perpetual memory." A representation of the occurrence is given by De Bry ('Petits Voyages,' part 4). The present reference to this map is "State Papers, Miscellaneous, bundle 37, No. 1." Unfortunately, the other contents of the bundle afford no clue to its history; but it would be interesting to know if any students of early cartography have come across a copy elsewhere. Mr. Atkinson has presented a photographic facsimile of the map to our collection, by kind permission of the Deputy Keeper of the Public Records.

A New Source of Alcohol.

In a recent number of the *Bulletin* of the Imperial Institute the possibility of utilizing the flowers of the well-known "Mahwa" tree of India as a source of alcohol for use as motor spirit is discussed. The flowers have thick juicy petals rich in sugar, used by the natives as a food-stuff and for the preparation of a fermented liquor called *daru* or *Mahwa* spirit, whilst the tree also produces a valuable oil-seed. During the war the flowers were used in India for the production of acetone, the yield being much greater than that obtained by distilling wood. The flowers would be available in large quantities for the manufacture of alcohol, and would be a cheap source of the product, the yield being high compared with that from potatoes or other materials commonly used. The possibility of producing motor-spirit from the Mohwa flowers on a commercial scale is said to have been already demonstrated, and running trials have proved the spirit satisfactory in use. The botanical name of the tree is *Bassia latifolia* (Roxb.), and it is closely allied to the "shea-butter" tree of West Africa.

Early Instruments for Navigation and Survey.

It is proposed to form shortly a small exhibition in the Museum of early instruments used in navigation and survey, with books and maps illustrating the history of survey methods and map projections. The Secretary will be glad to receive from Fellows and others, offers for the loan of astrolabes, quadrants, and other early types, or historical specimens of instruments.

OBITUARY

Rear-Admiral Robert E. Peary, U.S.N.

ROBERT EDWIN PEARY was born at Cresson Springs, Pennsylvania, on 6 May 1856, was educated at Bowdoin College, Brunswick, Maine, and after some experience as a land surveyor entered the civil-engineering branch of the United States Navy in 1881. His duties led him to Central America, where he was engaged on the survey of the projected Nicaragua Ship Canal from 1885 to 1887. Later he was engaged on naval dock construction in the United States, and rose in the service until he reached the rank of Rear-Admiral in 1911, and after several years of illness he died at Washington on 19 February 1920.

These facts and dates summarize a useful and successful official career which might satisfy the ambition of many a man; but they omit all that went to make the name of Peary live in the history of geographical exploration. The main current of his life flowed in a channel that, starting from a casual holiday trip to Greenland, deepened and widened until it led him to the crowning glory of Arctic travel, the attainment of the North Pole. This was no mere piece of luck such as might fall to the lot of any stout and strenuous

explorer who made a summer dash in a propitious season ; it was the outcome of carefully laid plans slowly evolved from hard experience and persevered in through years of toil and disappointment. Peary's Arctic history is worth recalling as it is in many ways unique, and it abounds with episodes of dramatic interest rare in modern travel.

While his work still lay in the tropical plains of Nicaragua Peary had read the account of Baron Nordenskiöld's exploration of Greenland, and he arranged for a visit to that country in the summer of 1886. With one companion he landed at Disco Bay on the west coast and endeavoured to cross the inland ice towards Mount Petermann on Franz Josef Fjord. He succeeded in reaching a point on the inland ice 100 miles from the edge and 7525 feet above the sea ; then he had to turn back. His experience confirmed the wisdom of the plan which Fridtjof Nansen, then a promising student of biology in Bergen, had formed of crossing Greenland from the less accessible east coast to the settlements on the west. It also satisfied Peary himself that the inland ice furnished "an imperial highway" to the northern extremity of Greenland practicable for dog-sledges. Five years passed before he was able to put it to the test. Then in 1891, with a party of seven persons, including Mrs. Peary and Dr. F. A. Cook, he established a base on Whale Sound, where he wintered, recovering from a serious accident which involved the fracture of a leg. In the spring of 1892 he started on a sledge journey over the inland ice with three companions, and returned in the late summer after sledging 1200 miles with evidence of the insularity of Greenland and the discovery of Independence Bay on its north-east coast. Another highly important result was the rediscovery of an isolated tribe of Eskimo ; their detailed anthropology was studied, the personal character of each individual was examined, and the confidence and friendship of the whole secured. Peary also demonstrated the truth of his hypothesis that the resources of the coast of northern Greenland would ensure an abundant supply of fresh meat for an indefinite period.

Such success made a second expedition possible, and in 1893 he was back at Whale Sound with a larger party, again including Mrs. Peary, whose daughter was born during the winter. The summer expedition of 1893 was disastrous, cut short by a blizzard of unexampled intensity, and most of the explorers found that they had had enough of it ; but Peary with one white man, Mr. Lee, and his negro servant Henson, who was proof against any cold, remained for a second winter, and in 1895, using a party of Eskino to assist in the first stages, he repeated the journey of 1892 to Independence Bay, though without much addition to geography. The experience of travel over the ice-cap was however of real importance in subsequent work. In 1896 and 1897 Peary returned to Whale Sound on summer trips, the object of which, accomplished with much difficulty, was the transport to America of three great masses of meteoric iron, the largest weighing 90 tons.

His mind was set on further Arctic exploration, but he said nothing on the subject until the results of the Jackson-Harmsworth expedition to Franz Josef Land and of Nansen's in the *Fram* were known. On 6 December 1897, when giving an account of his work in Greenland to the Royal Geographical Society (for which he received the Patron's Medal in the following year), Peary announced his plans for future exploration. He said that the only route to the Pole with *terra firma* as a base was that along the land north of Greenland, and by this route he intended to travel, aided by his Eskimo. He proposed to establish a settlement of these people in perfectly normal, self-supporting conditions at a point as far north as his ship could reach, possibly on Sherrard

Osborn Fjord in 82° N. During the autumn and winter he would move this settlement northward by slow degrees to the furthest point of land. Thence with two or three selected Eskimo he would make a direct journey to the Pole and back; if unsuccessful he would try again the next year, and the next, and would not desist for five years at least if success did not come sooner.

Lord Northcliffe presented to Peary the *Windward*, which had been the ship of the Jackson-Harmsworth expedition, and in her Peary sailed early in 1898 to carry out his plans. Meanwhile his friends in America established the Peary Arctic Club of New York under the presidency of Mr. Morris K. Jesup in order to raise funds and support the scheme of continuous exploration. Peary did not return until 1902, the result of his labours being the outlining of the northern limits of the Greenland archipelago and the attainment of 83° 50′ N. As a result of his experience Peary had a new ship designed with special reference to the difficulties she would have to meet, and while organizing the new expedition he presided over the highly successful meeting of the Eighth International Geographical Congress in the United States.

The *Roosevelt* carried the new expedition through Smith Sound and the northern channels to Cape Sheridan on the north coast of Grant Land in 83° N., and starting thence in March 1906 Peary sledged northward over the polar pack, dividing his party into groups with a day between each, so that the last and heaviest loads should find their way marked out and prepared for them and the snow-houses built ready for occupation. Unprecedentedly warm weather and high wind made the ice open and the drifting a serious danger, but Peary persevered "straining his life out" until April 21, when in 87° 6′ N. on the fiftieth meridian he had to turn, bitterly disappointed at his failure, though he confessed a little comforted by having beaten the Arctic record for latitude. On Christmas Eve 1906 the battered *Roosevelt*, having crept along the American coast with frequent halts for temporary repairs, entered New York harbour.

The Peary Arctic Club at once took the permanent repairs in hand, Peary received extended leave of absence, and in July 1908 he was off again on the same route with the same plan modified by experience, and burning with the determination to reach the Pole this time. The *Roosevelt* again crashed her way through the ice to the north coast of Grant Land, and on 1 March 1909 a start was made on the sea-ice northward from Cape Columbia, on the tested plan of successive parties following the same route with Eskimos to drive the dogs and build the igloos. This time success was reached after immense difficulties, and on 6 April 1909, having sent back all the other parties on the homeward trail, Peary reached a point on the drifting floes where an observation of the sun gave lat. 89° 57′ N.—3 miles from the Pole. A short sledge journey carried him over the coveted spot, and he wrote in his diary, "The Pole at last. The prize of three centuries. My dream and goal of twenty years. Mine at last. I cannot bring myself to realize it. It seems all so simple and commonplace." After a day's rest the return journey to Cape Columbia was accomplished in sixteen marches, and Peary felt as he touched land once more that his work was done and his life's work crowned by success. In September he was back in civilization; back also in a world of mingled praise and criticism. The claim of Dr. F. A. Cook to have reached the Pole a year earlier roused a section of the public in the United States to question Peary's good faith, and he felt bitterly the hardship of having to prove his common honesty before tribunals of his own countrymen. The verdict was in his favour, but the joy of achievement was gone. It is a pleasure to record that no such scepticism was

expressed in this country, and that the Royal Geographical Society awarded him a special gold medal at the earliest possible moment.

H. R. M.

Major Robert Hollister Chapman.

With the Topographic Corps of the United States Geological Survey for more than thirty years, during which he was engaged in exploring and mapping remote portions of the Western United States and Canada, Robert Hollister Chapman was widely known in the topographic and engineering circles of America. For a time he had charge of the administration of Glacier National Park in Montana, and at his death was Secretary of the American Alpine Club. During the war, as a Major of Engineers (Reserve Corps), he was Assistant to General Theodore Bingham, in connection with the defences of New York City and the production of aeroplane maps.

He was elected to the Royal Geographical Society in 1917. In 1915 and 1919 he made reconnaissance expeditions in British Columbia, the first to the Northern Selkirk Mountains in the Big Bend of the Columbia River, and the second into the little-known country south of Yellowhead Pass. Maps resulting from both are in preparation. For several years he was detailed to the Geological Survey of Canada, and initiated the triangulation survey of Vancouver Island.

He was a man of interesting personality, and his pleasing social qualities won him warm friends in every walk of life, from the rough men of his field parties to those in high official station. His death occurred 11 January 1920, in the 52nd year of his age.

H. P.

MEETINGS: ROYAL GEOGRAPHICAL SOCIETY: SESSION 1919–1920

Additional Evening Meeting in the Philharmonic Hall, Great Portland Street, W., 22 March 1920.—The President in the Chair.

PAPER: The 1914–1917 Antarctic Expedition. Sir Ernest Shackleton, C.V.O.

Eleventh Evening Meeting, 29 March 1920.—The President in the Chair.

ELECTIONS: W. E. D. Allen; Alexander Anderson, O.B.E.; Brig.-General Hon. C. G. Bruce, C.B., M.V.O.; Major-General Sir Hugh Bruce-Williams, K.C.B., D.S.O.; Roland L. E. Bryce; Leonard H. Dudley Buxton, M.A.; Captain E. C. B. Dale, M.C., R.A.; Frank Atkinson Danks, B.A.; Miss Bella Duffy; Lieut. H. Farrar, M.C., B.A., LL.B.; Reginald Graham; Miss B. Hosgood, B.A.; Lieut. H. Elliott Jagoe, R.G.A.; Reginald Kirkwood; Eustace McDonald, A.M.I.C.E.; Captain Edward C. Midwinter, C.B., C.M.G., C.B.E., D.S.O.; O. Leslie Morton; W. Nicholls; Theodore Reeves Palmer; J. A. Piggot; Clifford H. Fitzherbert Plowman; Lieut. A. J. Revell, I.A.; Major Patrick Villiers Stuart, D.S.O.; Rev. P. S. Toye; Lieut. Annesley Voysey, R.E.

PAPER: War and Discovery in Arabia. Commander D. G. Hogarth, C.M.G.

Sixth Afternoon Meeting, 12 April 1920.—The President in the Chair.

PAPER: A Brief Review of the Evidence upon which the Theory of Isostasy is based. Colonel Sir Sidney Burrard, K.C.S.I., F.R.S.